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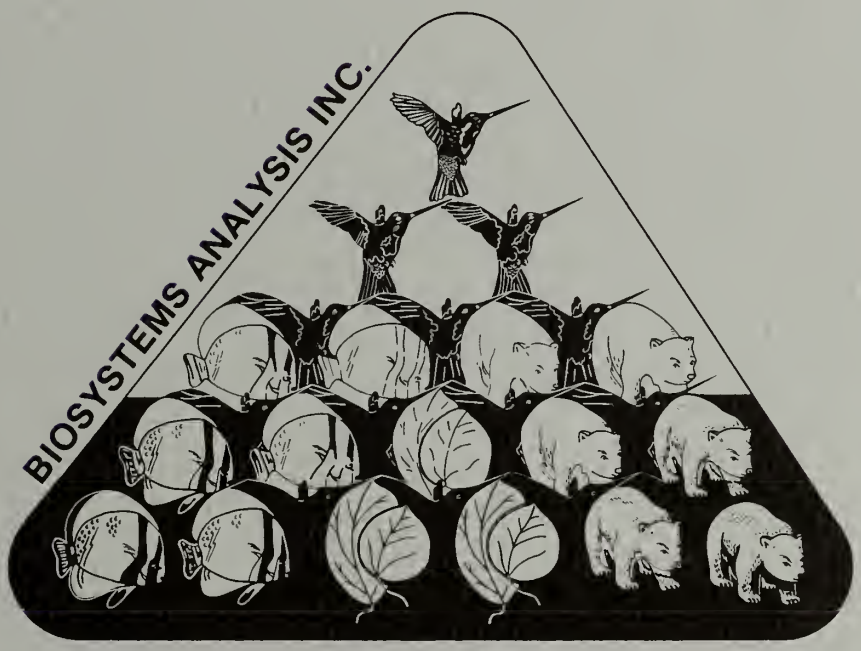
RIPARIAN VEGETATION ALONG TWO FORKS OF THE VIRGIN RIVER IN ZION NATIONAL PARK, UTAH



RIPARIAN VEGETATION ALONG TWO FORKS OF THE VIRGIN RIVER IN ZION NATIONAL PARK, UTAH

Prepared for:

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TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Background 1
1.2 Study Design and Objectives 2
1.3 Riparian Zone Terminology 5

2.0 METHODS 8
2.1 Orientation 8
2.2 Floristic Survey of Study Area Streams 8
2.3 Study Reaches and Study Area 9
2.4 Selection of Riparian Vegetation Study Methods 9
2.5 Field Sampling 10
2.6 Data Analysis Procedures 15

3.0 RESULTS 18
3.1 Floristic Characteristics of Zion National Park Riparian Vegetation . . . 18
3.2 Characteristics of Study Transects 18
3.3 Vegetation Characteristics of Study Reaches 21
3.4 Size-class Distribution of Riparian Trees 37
3.5 Riparian Zone Position of Dominant Species 42

4.0 LITERATURE CITED 47

APPENDIX A Riparian Plant Species List for Zion National Park
APPENDIX B Raw Tree Data Set
APPENDIX C Raw Herb Cover Data Set
APPENDIX D Raw Line-intercept Data Set

LIST OF TABLES

Table 1 Selected physiographic and riparian characteristics of study transects 19

Table 2 Cover summary tabulation for Transect Sampling sites 22

Table 3 Association table for the riparian vegetation in the Zion National Park study area 26

Table 4 Results of TWINSPAN classification of riparian vegetation in the Zion National Park study area 30

Table 5 Summary of diversity comparisons for the study reaches 37

Table 6 Riparian Zone position of seedlings, saplings, and adult trees as a funcion of stream channel geomorphology 43

LIST OF FIGURES

Figure 1 Approximate locations of North Fork Virgin River transects 3

Figure 2 Approximate locations of East Fork Virgin River transects 4

Figure 3 Riparian zonation terminology (following Campbell and Franklin 1979) used in this report 6

Figure 4 Map of relevé sampling locations 14

Figure 5 Histograms depicting the mean (bar height) and standard error (bracket) of plant cover by life-form for the transects in each study reach 25

Figure 6 Detrended Correspondence Analysis (DCA) ordination of 37 transect and relevé samples from the Zion National Park study area 32

Figure 7 Dendrogram depicting the results of cluster analysis of dissimilarity values (based on Euclidean distance) between transect and relevé samples from the Zion National Park study area 34

Figure 8 Mult-dimensional scaling (MDS) ordination of the relevé and transect sampling sites 35

Figure 9 Histogram depicting the proportion of stems by diameter class for *Populus fremontii* on the two study streams 39

Figure 10 Histogram depicting the proportion of stems by diameter class for *Fraxinus velutina* and *Acer negundo* on the North Fork study stream 40

Figure 11 Probability plots (Tukey 1977) characterizing the shape of the size-class distributions for *Populus fremontii* on the two study streams 41

Figure 12 Histogram depicting the location of individuals of *Populus fremontii* seedlings, saplings, and adult trees for the two study reaches 45

Figure 13 Histogram depicting the location of individuals of *Acer negundo* and *Fraxinus velutina* seedlings, saplings and adult trees for the North Fork study stream 46

1.0 INTRODUCTION

1.1 Background

Understanding the ecology of riparian vegetation is necessary for the evaluation of potential environmental impacts of water development projects. In the arid and semiarid southwest United States, riparian habitats are among the most productive of natural plant communities (Johnson and Jones 1977). Relative to their area, they provide a disproportionate contribution to the human benefits derived from natural landscapes (Johnson and McCormick 1978, Warner & Hendrix 1984). Recent concern has centered over the loss of riparian habitat that often results from streamflow modifications (Sands 1977), and the attendant loss of scenic, recreational and wildlife benefits (Johnson et al. 1985).

Riparian habitat is an important plant community in Zion National Park, Utah. Two major streams traverse the Park. Both are forks of the Virgin River, which in turn is a tributary of the Colorado River. The North Fork of the Virgin River flows through Zion Canyon in the central portion of the Park. The East Fork of the Virgin River flows through Parunuweap Canyon in the southeastern portion of the Park. The boundaries of Zion National Park do not encompass the entire headwaters of either the North Fork Virgin River or the East Fork Virgin River. Consequently, riparian ecosystems flanking Park streams are vulnerable to upstream land use practices and hydrologic modifications. Documentation of the structure and composition of riparian habitat within the Park is needed.

1.2 Study Design and Objectives

The overall design of the research program discussed in this report was specified by the National Park Service. The approach taken was to evaluate, in great detail, the existing conditions along two study reaches (one reach on each fork of the river, cf. Figures 1 & 2). Selection of the study reaches was predicated on several factors: 1) integration of divergent methodology of several disciplinary studies; 2) inferred sensitivity to changes in streamflow regime and sediment transport based on geomorphic features; 3) logistical considerations.

The basic assumption of the NPS studies is that the nature and degree of selected ecosystem responses to modified hydrology can be estimated on the basis of the responses exhibited by the two study reaches.

The present study on the ecology of riparian vegetation along two forks of the Virgin River in Zion National Park is organized into three phases:

> Phase 1. **Description Phase.** Characterize and quantify existing riparian vegetation conditions within the two study reaches.
>
> Phase 2. **Hydrologic Correlation Phase.** Establish the relationship between fluvial processes, hydrology and riparian vegetation.
>
> Phase 3. **Modeling Phase.** Utilizing inferences derived in Phase 2 above, determine potential changes in riparian vegetation conditions for selected hypothetical streamflow regimens.

This report provides the results of Phase 1: a detailed, quantitative description and characterization of the species composition and structure of riparian vegetation along the two study stream reaches.

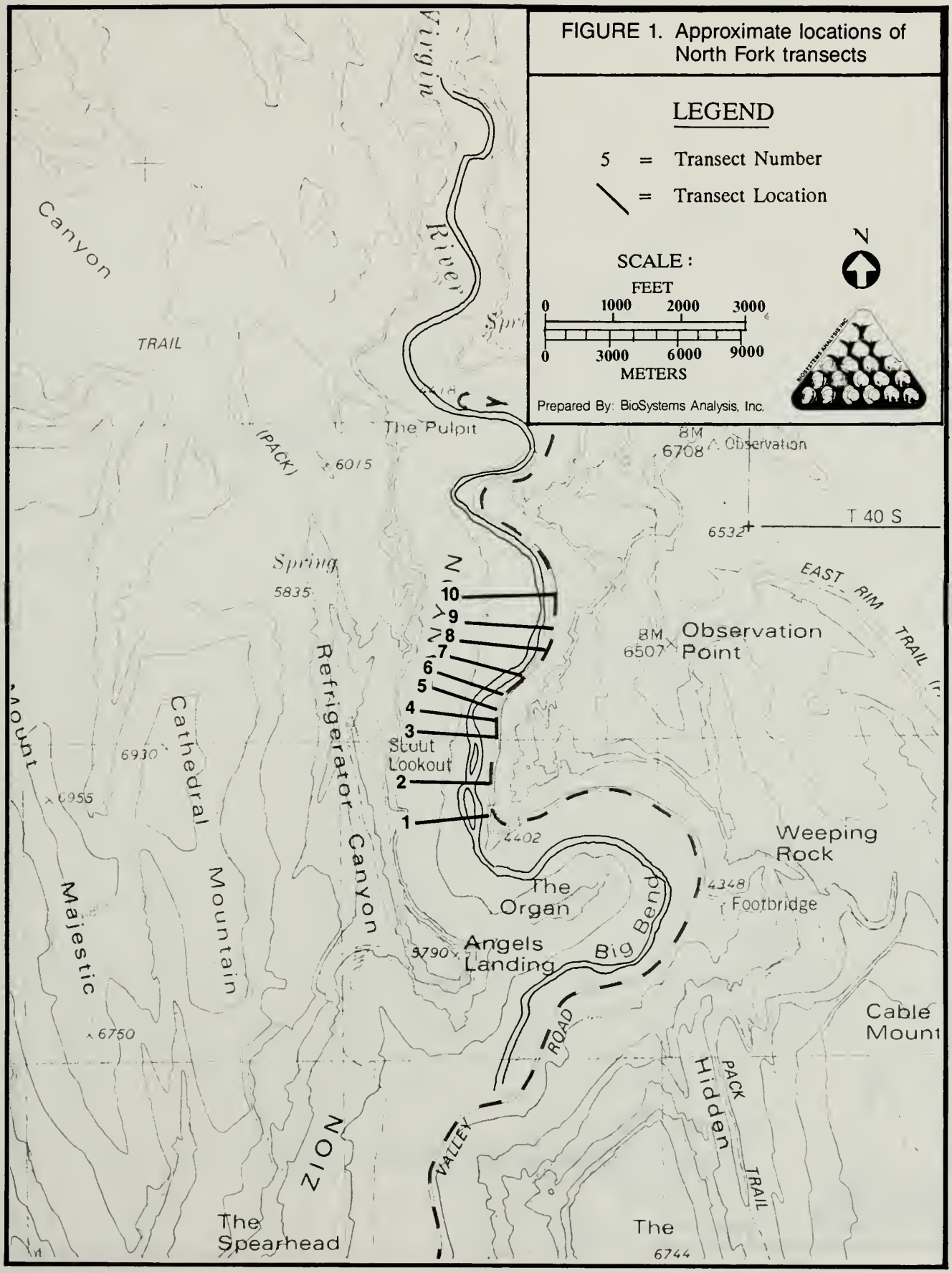


FIGURE 1. Approximate locations of North Fork transects
LEGEND
5 = Transect Number
= Transect Location
SCALE:
FEET
0 1000 2000 3000
0 3000 6000 9000
METERS
Prepared By: BioSystems Analysis, Inc.
N
Canyon
TRAIL
Virgin River
Spring
The Pulpit
6015
(PACK)
BM 6708
Observation
T 40 S
6532
Spring
5835
NORTH FORK
10
9
8
7
6
5
4
3
2
1
EAST RIM TRAIL
BM 6507
Observation Point
Refrigerator Canyon
Cathedral Mountain
6930
Stout Lookout
4402
Weeping Rock
4348
Footbridge
The Organ
Angels Landing
5790
Big Bend
Majestic Mountain
6955
6750
ROAD
VALLEY
PACK TRAIL
Hidden
Cable Mount
ZION
The Spearhead
The
6744

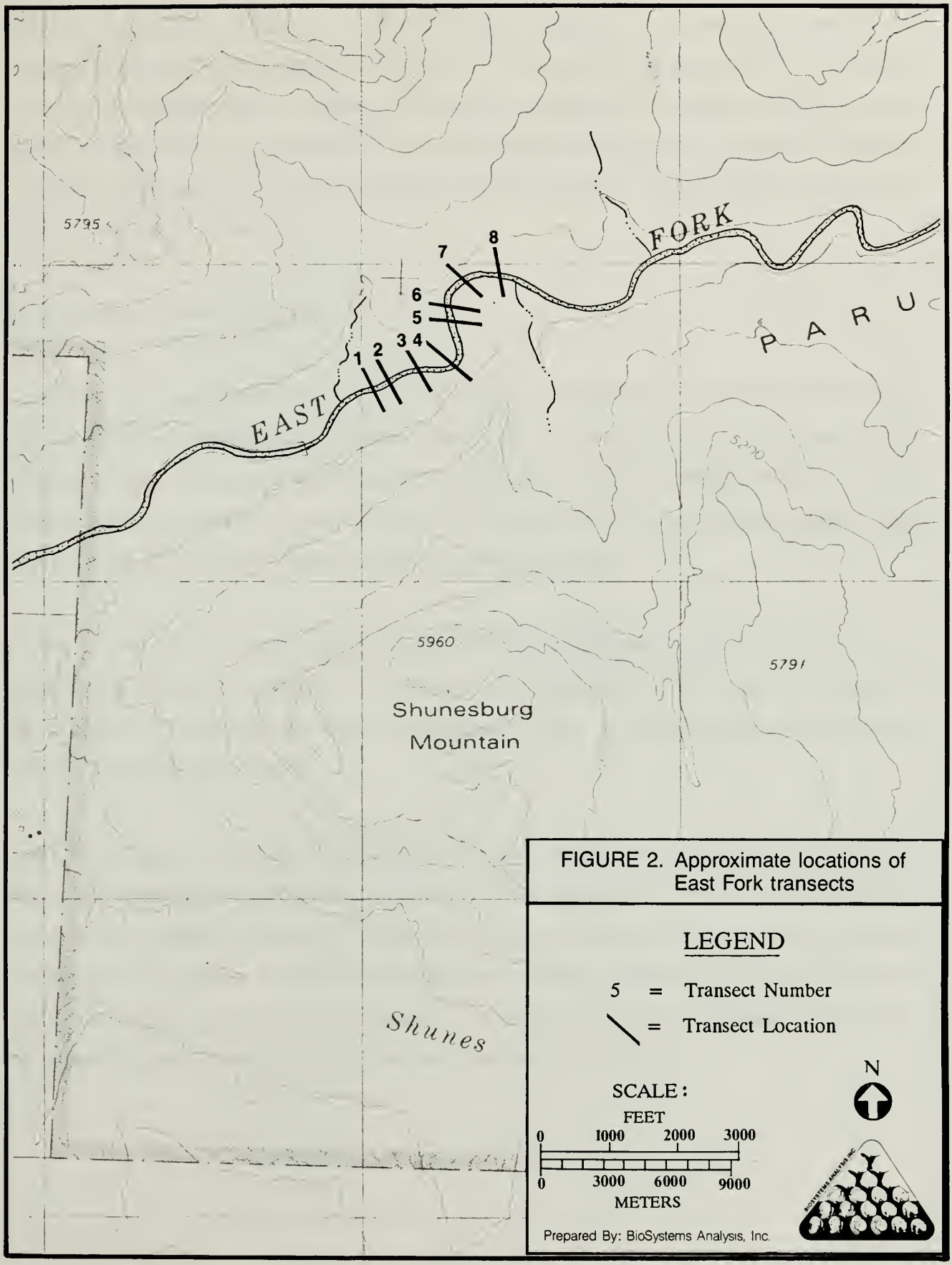


FIGURE 2. Approximate locations of East Fork transects

LEGEND

5 = Transect Number

\ = Transect Location

N

SCALE:

FEET

0 1000 2000 3000

0 3000 6000 9000

METERS

Prepared By: BioSystems Analysis, Inc.

Review of pertinent literature on the ecological responses of riparian vegetation to changed hydrology is not provided in this report. The present document does not attempt to model the relationships of riparian vegetation in relation to hydrology along the study stream reaches, nor does it attempt to predict the mode and tempo of potential changes in riparian vegetation that may result from changed hydrology. These aspects of the study will be covered in a final report.

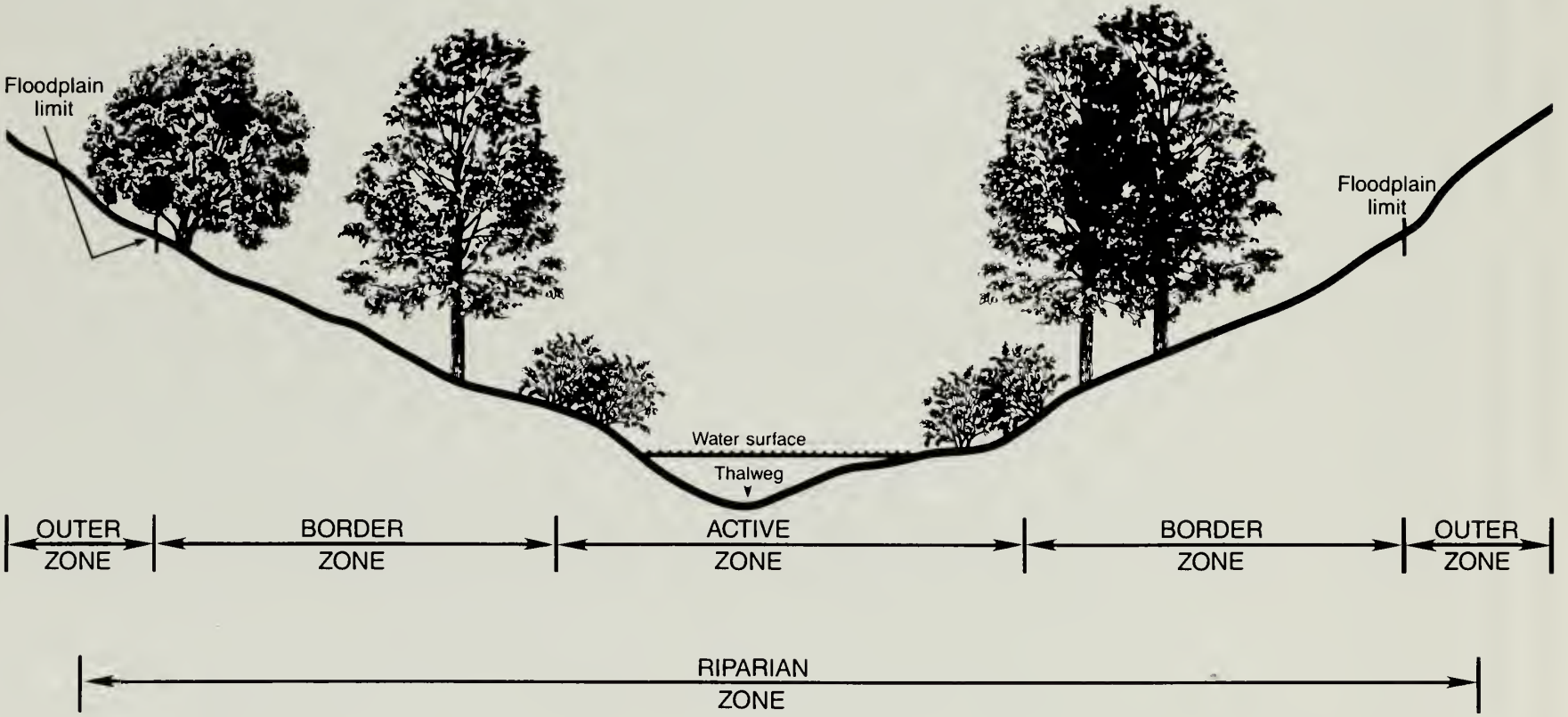
1.3 Riparian Zone Terminology

The Riparian Zone terminology used in this report corresponds to Campbell and Franklin (1979). Because fluvial environments are linear and spatially dynamic, they are ecologically heterogeneous. Consequently, division of the Riparian Zone into component Outer Zone, Border Zone and Active Zone provides for homogeneity of data, allowing analysis and inference on the basis of position within the Riparian Zone.

Figure 3 depicts the relationship between the three Riparian Zone subdivisions in a hypothetical stream cross-section. The Border Zone and Active Zone together constitute the floodplain of a typical stream: that land surface that is directly influenced by fluvial activity (Leopold et al. 1964).

The Outer Zone is a transitional area between the fluvial and the non-fluvial environment, and often supports a mixture of both upland and riparian plants. Soils of the Outer Zone are typically upland (residual or colluvial) soils that are not derived from or directly influenced by flooding. Plants that are otherwise obligate riparian plants often occur in the Outer Zone because of the presence of a stream-ameliorated microclimate, or because of accessible groundwater derived from streamflow (Odum 1978).

Figure 3. Riparian zonation terminology (following Campbell and Franklin 1979) used in this report.



The Border Zone is the portion of the floodplain that is inundated by water only during infrequent, high-discharge events. The Active Zone comprises the active channel of the stream, defined laterally by the inundation limits at bankfull discharge. Typically, most streams reach bankfull discharge at least once within a two year period (Dunne and Leopold 1978).

2.0 METHODS

The choice of study methods used in this research was predicated on 1) the overall NPS study design, and 2) previous studies on the ecological consequences of streamflow modification on riparian vegetation (Taylor and Davilla 1985, 1986; Brock 1987; Harris et al. 1985; Reily and Johnson 1982; Fenner et al. 1985).

2.1 Orientation

Prior to data collection, BioSystems botanists visited selected locations along the length of the North Fork Virgin River and East Fork Virgin River to inspect riparian vegetation conditions. Particular attention was paid to taxonomic determination of dominant as well as less common species. Potential considerations in relation to the planned data collection were evaluated (e.g., belt transect width, field time requirements). Portions of the Virgin River watershed upstream and downstream of Zion National Park were visited in this orientation.

2.2 Floristic Survey of Study Area Streams

Prior to intensive field work, BioSystems conducted a field review of the riparian flora along the North Fork Virgin River and the East Fork Virgin River within the boundaries of the Park. A checklist was assembled of all vascular plant species observed in riparian habitats within the Park. Voucher specimens were collected of critical taxa: mostly species of grasses (Poaceae), willow (*Salix*), rushes (*Juncus*) and sedges (*Carex*). Species were identified in the field with the aid of Welsh et al. (1987) except where supplanted by Cronquist et. al (1972, 1977, 1984). Common names used in the report generally correspond to Welsh et al. (1987). Nomenclature used in the report corresponds to

Kartesz and Kartesz (1980), except those taxa treated by Cronquist et al. (1972, 1977, 1984).

2.3 Study Reaches and Study Area

The locations of the two study reaches selected for inventory are depicted in Figures 1 & 2. The length of each study reach is comparable, each roughly 1200 m (4000 ft). The North Fork Virgin River study reach is located at the northern end of Zion Canyon, about 2 miles downstream from the mouth of the 'Narrows'. Bank and channel characteristics within this reach are for the most part natural. Bank erosion control structures occur on one side of the study reach, consisting of revetments ('rip-rap') in the upper third of the study reach adjacent to a roadway. The form of the channel within this study reach is typical of a low-gradient stream with a straight channel, confined between steep canyon walls.

The East Fork study reach is located ca. 2 miles upstream from the confluence of Shunes Creek and the East Fork, ca. 1 mile within the Park boundary in Parunuweap Canyon. The study reach is a low gradient reach with an incised meander sequence. Both streambanks within the study reach are composed primarily of alluvium.

In this report, the Study Area is the North Fork of the Virgin River within and below Zion Canyon, the East Fork of the Virgin River below the lower end of Parunuweap Canyon, and major perennial or larger-order ephemeral tributaries of the two forks.

2.4 Selection of Riparian Vegetation Study Methods

Field inspection of vegetation within the Study Area and review of relevant literature on riparian vegetation suggested the use of a two-staged sampling protocol emphasizing: 1)

intensive (transect-based) sampling of the two selected study reaches, supplemented with 2) relevé (stand survey) sampling from a variety of riparian sites within the Study Area. Relevé sampling provided supplemental data on floristic composition from locations other than the study reaches without additional intensive, transect-based vegetation sampling.

2.5 Field Sampling

2.5.1 Transect Sampling

Transect sampling methods were used to collect quantitative vegetation data from specific sites within the two study reaches. Transect sampling sites are shown on Figures 1 & 2. Field data were recorded on coding forms specifically designed for this purpose.

Transect Field Methods - Data were collected on stream channel geomorphology, substrate, and vegetation using transects oriented perpendicular to the stream. The transects sampled were those subjectively chosen by previous investigators in conjunction with other NPS studies in the study program. These transects were chosen to reflect stream channel geomorphic conditions, hence, they are not likely to reflect a direct bias with regard to vegetation characteristics. The sampled transects were placed at approximately 30 to 50 m (ca. 100-160 ft) intervals along the study reaches.

Transects were sampled using a measuring tape set at right angles to the stream. The start and end of each transect were determined by the limits of fluvial activity. The lateral transect boundaries were largely restricted to the portion of the floodplain exhibiting direct evidence of recent (30-50 yr.) fluvial activity. These limits were judged by a combination of geomorphic and vegetation features including the presence of floated woody debris, erosional or depositional features, moss lines, changes from residual to depositional soils, and changes from obligate riparian to upland plant species. Transects

were extended into the Outer Zone only to the limit of cover exhibited by obligate riparian trees.

Data were recorded as the cumulative distance from the transect origin. A land-surface elevation profile of each transect was surveyed by the NPS. These elevations are accurate to 3.0 cm (1.2 in). The profiles were surveyed using a tripod-mounted autolevel and leveling rod. This profile was supplemented with data on the water depth, channel width, and position of the channel thalweg (deepest portion of the channel) at the time of sampling.

Data on trees were collected using a 10-m wide belt transect (Mueller-Dombois and Ellenberg 1974) coincident with and centered on the tape at each transect. Tree diameter at breast height (DBH) was measured with diameter tape (to the nearest cm) for all stems greater than or equal to 1 cm DBH. Where tree density was excessively high or low, the width of the belt transect was decreased or increased between 4 and 20 m, respectively, in order to obtain sufficient sample sizes for analysis. For each tree, the substrate at its rooted position was noted (see below for substrate categories).

Line-intercept data (Mueller-Dombois and Ellenberg 1974) were collected for all woody plants (trees, shrubs and vines) on the transect. Absolute cover and relative cover of woody plants were calculated as the proportion and relative proportion of intercepted distance along the tape. Cover of herbaceous plants (forbs and graminoids) on the transect was estimated in $1m^2$ quadrats located at 1-3 m intervals along the tape. Quadrat spacing was adjusted to obtain ca. 30 quadrats per transect, depending on transect length. Successive quadrats were located on alternating sides of the tape. Within each quadrat, cover of vascular plants was estimated to the nearest 0.01 m^2. Surficial substrate was noted within each quadrat according to the following classification:

Substrate Class	Particle Diameter
Bedrock	Rock in place
Large Boulders	>8 dm
Small Boulders	2 dm - 8 dm
Cobbles	6 cm - 2 dm
Sand	<2 mm

2.5.2 Relevé Sampling

Systematic synecological surveys of riparian vegetation structure and composition along streams in the lower North Fork Virgin River and lower East Fork Virgin River were conducted using the relevé method. This method of plotless stand survey, in which plant cover is estimated rather than measured, is an efficient way of gathering vegetation data over large areas (Mueller-Dombois and Ellenberg 1974). Relevé sampling was conducted to collect data on floristic composition of riparian vegetation from a variety of sites. This floristic data will be used to aid modeling of compositional changes expected from streamflow modification.

Relevé Field Methods: Sites for relevé sampling were on a variety of Study Area streams. Once a reach had been identified for sampling, it was inspected for obvious anthropogenic disturbance (other than flow diversion). Significantly disturbed portions of reaches (bridges, dams, diversion structures, roads) that altered channel morphology within the Riparian Zone were not sampled. All relevé sites thus chosen for sampling were homogeneous with respect to vegetation and geomorphology, as subjectively judged in the field.

Relevé sample size was fixed by the width of the floodplain and a species-area curve. Relevé length was determined by a species-area curve (Daubenmire 1968) whereby sample area was increased upstream or downstream until the number of species observed within

the relevé remained relatively constant. Field data were recorded on a specific sampling form prepared for this purpose.

All vascular plant species observed within each relevé were identified (taxonomic nomenclature in this report follows Kartesz and Kartesz 1980), and cover of each species was estimated using the following scale of precision:

Observed Cover Value	**Estimated to the Nearest**
<1%	0.1%
1-10%	1.0%
>10%	5.0%

This scale was also used to estimate the cover of various life-form categories within specific riparian zones at each relevé (Appendix B). For trees, canopy height was estimated to the nearest meter using a clinometer, and for shrubs and herbs, to the nearest decimeter using a meter tape. Elevation of each relevé site was determined using an altimeter or from U.S. Geological Survey 1:24,000-scale topographic maps. Aspect of the main stream channel was determined using a compass. Inclination of the valley slope adjacent to the relevé was determined using a clinometer. Stream gradient and Gradient Index (Hack 1973) for each relevé was determined from 1:24,000-scale topographic maps. Width of the floodplain, length of the relevé, Active Zone width and Border Zone width (Campbell and Franklin 1979) were paced or estimated with a rangefinder. Proportion of the relevé area underlain by various substrate classes was estimated visually for the Active Zone and Border Zone. Sites sampled using relevé techniques within the Study Area and vicinity are shown in Figure 4.

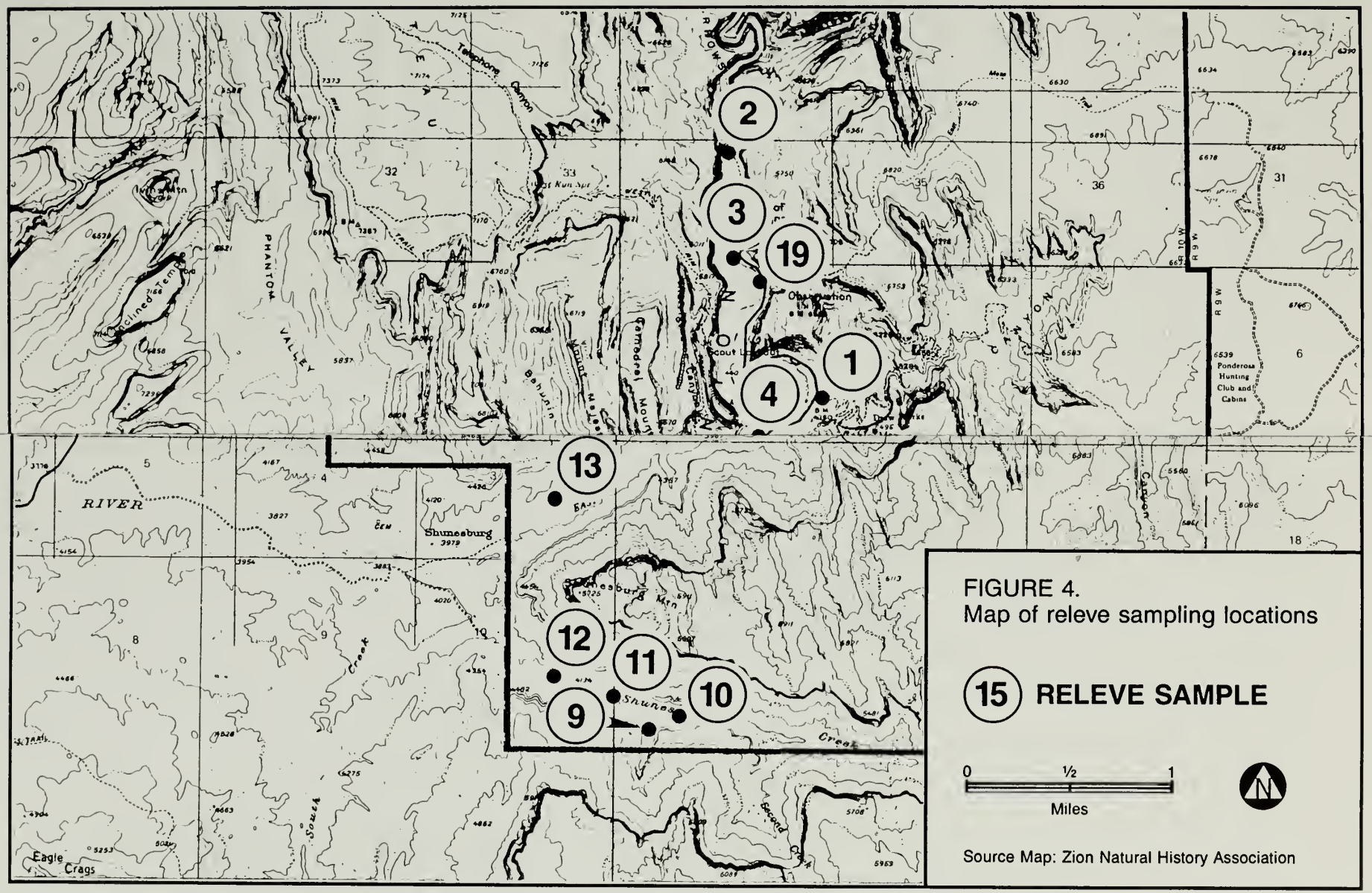
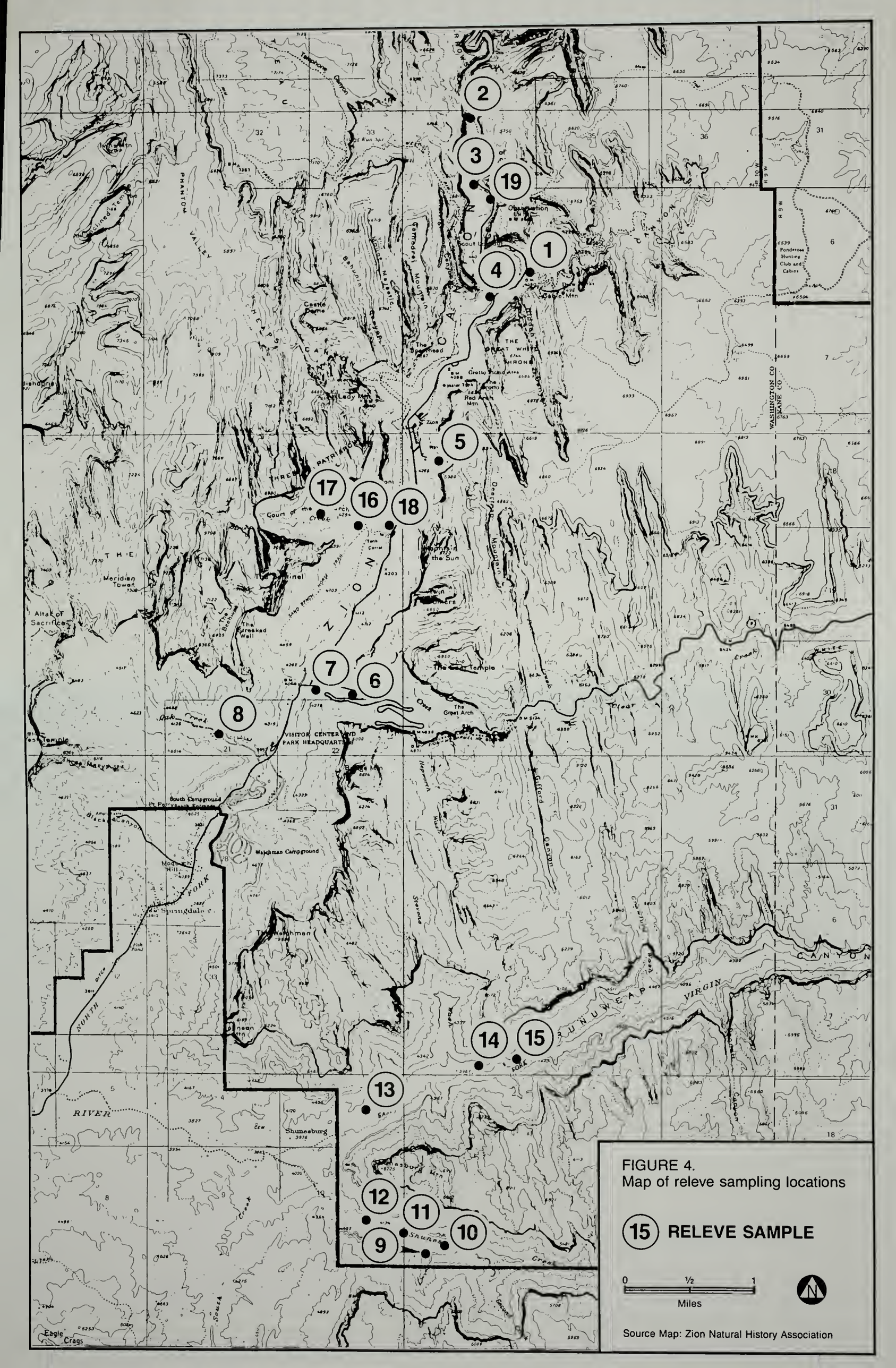


FIGURE 4.
Map of releve sampling locations

(15) **RELEVE SAMPLE**

Source Map: Zion Natural History Association


2
3
19
1
4
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9
FIGURE 4.
Map of releve sampling locations
15 RELEVE SAMPLE
0 ½ 1
Miles
Source Map: Zion Natural History Association

2.6 Data Analysis Procedures

Data were collected in the field using specific sampling forms. All field data were stored on a microcomputer. Data verification was accomplished manually by comparison of field coding forms with computer files. Statistical computations were made utilizing SYSTAT (Wilkinson 1987).

Relevé and transect data collected in this study were analyzed using a variety of univariate, bivariate and multivariate methods. The statistical analysis methods used were chosen to reflect the overall study objective: predicting potential changes in riparian vegetation in response to streamflow modifications. Univariate statistics in this report are arithmetic means (± 1 standard error of the mean) unless otherwise indicated.

Multivariate comparisons of the vegetation data collected in this study were made using combined ordination-classification techniques (Whittaker 1978a, 1978b; Gauch 1982). The objective of these analyses was to identify patterns of vegetation variation in relation to environmental factors. Riparian community-types were identified using two distinct classification techniques: divisive and agglomerative. Agglomerative analysis was conducted using the technique of Ceska & Roemer (1971), whereby groups of species that have similar occurrence patterns within a collection of samples are identified. To identify species groups, the analysis algorithm proceeds by first selecting an artificial group of the first two species encountered that have 50% of the sampled stands in common. All other species are evaluated for inclusion in the group. If a species occurs in at least 50% of the stands containing a group, and no more than 20% of its occurrences are in stands lacking a group, it is added to the group. All possible combinations of species are screened for group membership, with second and subsequent groups being formed in the same manner. The procedure continues iteratively until the results stabilize: no new groups are formed nor does membership in groups change. The nature of this type of analysis is such that

it is the equivalent of the traditional phytosociological table, as sorted by hand (Braun-Blanquet 1928, cf. Barbour et al. 1987). The analysis was accomplished using the COENOS program written by H. Ceska (pers. comm., 1987) for microcomputer. For this analysis, we used the default parameter settings in COENOS.

Divisive classification of the data set was undertaken using Two-Way Indicator Species Analysis (abbreviated TWINSPAN, Hill et al. 1975, Hill 1979a). The TWINSPAN algorithm produces an ordered, two-way classification of species and samples (i.e., relevés or transects) using a divisive approach. To arrive at an ordered species-sample matrix, TWINSPAN first orders the matrix using Reciprocal Averaging Ordination (abbreviated RA, Hill 1973). RA proceeds by first randomly assigning each sample a number between 0 and 100. Species scores are calculated based on their proportional abundance in each sample. The species scores are ordered, and then are used to calculate a new sample score based on the sum of the species scores. This iterative procedure continues until the results stabilize, based on the difference in eigenvalue of the species-stand matrix. TWINSPAN then divides the RA ordination axis into two equal parts for both the species and samples, reorders each half using RA ordination, divides each half, reorders, and so on until a specific number of divisions is reached. The resultant community-classification is hierarchical, with the first several division levels corresponding to major vegetation units. We used the default parameter settings specified in Hill (1979a) to govern the selection of TWINSPAN axis division criteria. Computation was conducted on a microcomputer.

Dissimilarity values, comparing floristic composition, were calculated for all pair-wise comparisons between transect and relevé samples. Euclidean distance, a geometric measure of the similarity in both species composition and cover between stands (Whittaker 1980), was calculated (using MVSP, Kovach 1986). Cluster analysis using the dissimilarity values was conducted using the farthest neighbor method (Frenkel and Harrison 1974). Cluster analysis produces a dendrogram whereby a stand is linked to its most similar

neighbor, that pair is then linked to its most similar neighbor or another pair, and so forth until all sampled are joined. Multi-dimensional scaling (MDS, Borg 1981) was used to graphically array the correspondence between calculated dissimilarity values. Multi-dimensional scaling uses non-parametric methods to compute coordinates for a set of points in a space such that the distances between points corresponds as closely as possible to actual dissimilarity values.

Multivariate trends in riparian vegetation were represented using an ordination technique known as Detrended Correspondence Analysis (abbreviated DCA, Hill 1979b, Hill and Gauch 1980). This technique reduces the variation inherent in a species-sample matrix to a workable number of dimensions (Barbour et al. 1987). Major trends in vegetation variation can then be related to environmental gradients, and conclusions drawn regarding community dynamics. DCA ordination is a minor modification of RA ordination whereby the scores of the second and higher axes of the ordination are adjusted to compensate for algebraic distortion (Gauch 1982). DCA and RA ordination are equivalent for the first ordination axis, and thus TWINSPAN is based on the computationally less complex ordination procedure.

3.0 RESULTS

3.1 Floristic Characteristics of Zion National Park Riparian Vegetation

Appendix A provides a complete list of all vascular plant species observed growing in riparian sites within the Study Area. A total of 270 taxa were encountered in riparian habitats. Of this number, the majority (ca. 80%) can be considered obligate or facultative riparian species, whereas the remainder are upland species which occasionally inhabit riparian sites. Obligate riparian plants are those species that are largely restricted to riparian habitats, and are largely absent or sporadic in upland habitats. In general, obligate riparian plants are hydrophytes or mesophytes that require high site moisture availability (Bell 1980) and are flooding tolerant or insensitive (Menges and Waller 1983). Obligate riparian species can often occur in non-riparian sites, but only where soil moisture in excess of that derived from precipitation is available. Facultative riparian plants are taxa with a large proportion of their populations centered in riparian habitats, but which occur frequently in the mesic portion of topoedaphic gradients within upland landscapes. Appendices B through D provide the raw tree, shrub and herb transect data sets.

3.2 Characteristics of Study Transects

Floodplain Width - Table 1 summarizes selected characteristics of the 18 study transects. In general, the length of transects sampled was on the order of ca. 100-150 m (320-490 ft). A total of 2.6 km (1.6 mi) of transect was sampled: 1.3 km (0.8 mi) on the North Fork, and 1.2 km (0.7 mi) on the East Fork. Average transect length was nearly the same for the North Fork and East Fork, although 3 of 10 transects on the North Fork were >170 m (550 ft), while only a single transect on the East Fork was of this length. Since transect length was determined by the limits of recent fluvial activity, these widths are reflective of the floodplain width along the study reaches.

Table 1. Selected physiographic and riparian characteristics of study transects.

Transect	Transect Length (m)	Belt Transect Width (m)	Proportional Width of Riparian Zones			Substrate Characteristics							Number of Trees Sampled
									Boulders			Woody	
			Outer	Border	Active	Sand	Gravel	Cobbles	Small	Large	Bedrock	Debris	
North Fork													
1	118.7	10	8.0	84.3	7.6	96.3	-	3.7	-	-	-	-	81
2	119.7	20	4.7	34.6	60.7	83.2	-	11.9	5.0	-	-	-	101
3	99.5	20	2.5	67.0	30.4	69.4	11.3	17.7	1.6	-	-	-	62
4	103.0	20	6.0	79.3	14.6	76.5	-	22.1	1.5	-	-	-	68
5	108.0	14	4.5	71.3	24.0	78.0	4.9	4.9	4.9	-	-	7.3	41
6	100.0	14	13.2	72.8	14.0	51.9	9.6	15.4	13.5	7.7	-	1.9	52
7	123.0	20	8.9	68.3	22.7	82.9	-	7.3	9.8	-	-	-	41
8	169.3	8	4.3	79.6	16.0	100.0	-	-	-	-	-	-	84
9	183.4	8	3.7	77.8	18.4	96.9	-	1.0	2.1	-	-	-	93
10	183.4	5	5.6	81.8	12.4	83.9	-	16.1	-	-	-	-	47
Mean	130.8		6.1	71.7	22.1	84.2	2.1	9.4	3.2	0.6	0.0	0.6	682
East Fork													
1	110.3	20	12.8	77.7	9.3	82.1	15.4	2.6	-	-	-	-	39
2	121.7	14	6.0	88.0	5.9	91.7	5.0	3.3	-	-	-	-	60
3	129.0	14	26.7	66.2	7.1	75.9	15.5	3.4	-	-	-	5.2	58
4	128.0	14	16.5	74.5	8.9	88.2	7.8	2.0	2.0	-	-	-	51
5	172.4	14	3.7	89.8	6.5	97.2	-	-	2.8	-	-	-	71
6	140.8	20	11.7	81.4	6.8	95.3	4.7	-	-	-	-	-	43
7	127.3	7	7.3	83.8	8.8	86.8	5.3	5.3	-	2.6	-	-	38
8	75.0	7	23.3	65.8	10.8	63.4	29.3	-	7.3	-	-	-	41
Mean	125.5		13.5	78.4	8.0	86.0	2.0	9.5	1.5	0.2	0.0	0.7	401

Riparian Zonation - The width of the Active Zone (i.e., the bankfull stream width, cf. Campbell and Franklin 1979) averaged 9.8 ± 0.5 m (32.1 ± 1.6 ft) on the East Fork and 27.9 ± 5.5 m (91.5 ± 18.0 ft) on the North Fork. In general, the Active Zone occupied a greater proportion of the Riparian Zone on the North Fork than on the East Fork (22.1% and 8.0%, respectively). Width of the Active Zone was more variable on the East Fork than on the North Fork transects.

Mid-channel bars occurred on four of the North Fork transects, but were absent from the East Fork transects. The width of mid-channel bars, as intersected by the transect, ranged from 5-60 m (16-196 ft), which represents 5-45% of the transect length. Mid-channel bars on the North Fork study reach were heavily vegetated with herbaceous species, and represented a significant site for seedling establishment. The transects on the North Fork can be floristically subdivided into two classes based on the presence or absence of a mid-channel bar dominated by herbaceous vegetation. Lack of large trees or shrubs on these bars suggests that the present flood frequency precludes establishment of woody plants.

The Border Zone comprised 70-75% of the transect length. A single transect on the North Fork (Transect No. 2) is an outlier in this regard, as the width of the Border Zone along this transect was much less (34.6%) than all other transects (cf. Table 1). The width of the Outer Zone is generally a small proportion of transect length, reflecting an often abrupt transition to upland conditions.

Substrate Characteristics - The relative proportion of various classes of substrate, based on particle size, along the sampled transects is given in Table 1. The relative abundance of substrates given in Table 1 was derived from two data sources: 1) as determined from tree rooted position data, and 2) surficial inspection of $1m^2$ quadrats. A total of 1,691 observations were made.

Sand was by far the most frequently encountered substrate type, comprising ca. 85% of the available habitat for plants. Cobble-sized particles were more abundant than gravel or boulders. No bedrock occurred along the sampled transects, so that the entire riparian zone can be considered as suitable habitat available for plant growth. Very little woody debris was present along the transects (Table 1). Surficial substrate characteristics are known to change within the Active Zone of both study reaches in response flash floods, which mobilize substantial quantities of sand (A. Johns, pers. comm.).

3.3 Vegetation Characteristics of Study Reaches

3.3.1 Results of Transect Sampling

Cover Characteristics of the Study Reaches - Crown interception of all woody plants (trees, shrubs and vines) was measured along 2.6 km (1.6 mi) of transects across the study reaches. Ten transects were sampled on the North Fork, 8 on the East Fork. Table 2 provides a tabulation of cover by species and site, ranked in descending order of importance (as determined by cover).

Among trees, Fremont cottonwood (*Populus fremontii*) was the only tree that was intersected on both the North Fork transects and East Fork transects. *Populus fremontii* was the dominant tree on the East Fork transects, averaging about 10% cover. It was a codominant of the North Fork transects, also with a cover of about 10%. The major difference between the overstory vegetation on the two forks of the Virgin River was the more diverse tree community on the North Fork, where box elder (*Acer negundo* var. *negundo*), velvet ash (*Fraxinus velutina*) and salt-cedar (*Tamarix ramosissima*) were important codominants, averaging about 10% cover for *Acer* and *Fraxinus*, and 5% for the non-native *Tamarix*.

Table 2. Cover summary tabulation for Transect Sampling sites.

		North Fork			East Fork		
		N	Mean Cover	S.E.	N	Mean Cover	S.E.
TREES							
	Acer negundo	10	12.953	2.803	.	.	.
	Fraxinus velutina	7	10.454	1.664	.	.	.
	Populus fremontii	7	9.487	3.210	8	10.223	1.666
	Tamarix ramosissima	9	5.912	2.765	.	.	.
	Celtis reticulata	4	1.384	0.339	.	.	.
	Juniperus osteosperma	.	.	.	4	1.999	0.777
VINES							
	Vitis arizonicus	3	2.381	1.337	.	.	.
SHRUBS							
	Baccharis emoryi	10	7.146	1.862	8	5.261	1.509
	Baccharis glutinosa	1	6.332	.	3	5.494	5.303
	Salix exigua	1	0.084	.	7	3.200	0.756
	Psorothamnus fremontii	.	.	.	2	4.990	4.060
	Chrysothamnus nauseosus	.	.	.	8	7.566	1.207
	Atriplex canescens	.	.	.	2	2.922	1.431
	Artemisia filiformis	.	.	.	5	2.748	0.541
SUCCULENTS							
	Opuntia phaecantha major	2	0.451	0.250	2	1.116	0.335
HERBS							
	Bromus diandrus	10	16.897	3.203	.	.	.
	Heterotheca villosa	10	8.010	1.629	2	0.189	0.094
	Asrostis stolonifera	8	6.319	1.395	1	0.032	.
	Festuca eliator	10	3.496	0.556	.	.	.
	Equisetum arvense	8	3.427	1.111	6	0.431	0.191
	Muhlenbergia asperifolia	6	3.400	1.356	4	0.395	0.167
	Poa pratensis	6	2.609	1.712	.	.	.
	Sporobolis cryptandrus	9	2.475	0.606	6	1.455	0.446
	Sporobolis flexuosus	2	2.332	1.971	3	5.464	0.413
	Agyopyron trachycaulum	5	1.980	0.654	1	0.092	.
	Sporobolis contractus	8	1.900	0.669	7	1.879	0.600
	Juncus ensifolius brun.	2	1.863	1.203	.	.	.
	Bromus tectorum	6	1.751	0.623	8	10.474	2.256
	Senecio spartioides	7	1.214	0.491	1	0.541	.
	Juncus balticus	5	1.137	0.558	1	0.631	.
	Equisetum arvense	5	1.040	0.683	2	0.251	0.209
	Scripus pumilus	1	0.777	.	8	2.387	0.502
	Verbascum thapsus	4	0.661	0.291	.	.	.
	Juncus ensifolius mont.	3	0.461	0.144	.	.	.
	Poa glaucifolia	8	0.339	0.058	.	.	.
	Muhlenbergia andina	3	0.303	0.197	.	.	.
	Ranunculus cymbalaria	4	0.297	0.098	.	.	.
	Artemisia ludoviciana	4	0.212	0.111	1	1.894	.
	Melalotus indicus	4	0.204	0.048	1	0.048	.
	Melalotus alba	6	0.174	0.053	7	0.525	0.177
	Machaeranthera tanacet.	2	0.151	0.043	5	0.479	0.210
	Oenothera longissima	4	0.150	0.097	.	.	.
	Astraglulus miser	2	0.135	0.095	1	0.042	.
	Euthamia occidentalis	4	0.130	0.056	.	.	.
	Aristida longiaristata	1	0.121	.	8	2.002	0.475
	Aster chilensis ascend.	3	0.110	0.035	.	.	.
	Sitanion jubatum	3	0.109	0.045	.	.	.
	Conyza canadensis	5	0.092	0.017	.	.	.
	Erigeron divergens	4	0.073	0.010	.	.	.
	Gutierrezia microcephala	1	0.046	.	4	1.001	0.253
	Scirpus microcarpus	1	0.039	.	2	0.809	0.340
	Oenothera pallida	1	0.036	.	4	0.392	0.207
	Linum aristatum	.	.	.	5	0.109	0.031
	Ambrosia acanthocarpa	.	.	.	6	0.145	0.054
	Oryzopsis hymenoides	.	.	.	5	0.487	0.222
	Munroa squarrosa	.	.	.	3	0.981	0.722
	Psoralea lanceolata	.	.	.	8	4.522	0.888
MOSSES		3	3.732	0.347	7	2.831	0.709

Vines (lianas) were a floristic element that differentiated the riparian vegetation on the North Fork from that on the East Fork. On the North Fork transects, canyon grape (*Vitis arizonica*) was a conspicuous element of the vegetation. Most often, *Vitis* would completely drape large *Acer negundo*, or more rarely *Fraxinus* or *Populus*. Vines covered only 2% of the sampled transects. However, their contribution to stand biomass was probably much greater than 2%, and is poorly reflected by their cover as measured by line-intercept sampling.

Shrub cover on the East Fork was more diverse than on the North Fork, consisting of both obligate riparian taxa and upland (non-riparian) taxa. Obligate riparian shrubs on the East Fork included: seepwillow (*Baccharis emoryi*), which occurred on all 8 transects with a cover of about 5%; gray-willow (*Salix exigua*), which occurred on 7 of 8 transects with a cover of 3%; and glandular seepwillow (*Baccharis glutinosa*), which occurred on 3 of 8 transects with a cover of 5%. By contrast, shrub cover on the North Fork consisted exclusively of obligate riparian taxa. Upland (non-riparian) shrubs were not found in the Riparian Zone. Only *Baccharis emoryi* was frequent on the North Fork, occurring on all 10 transects, with a cover of 7%.

Herb diversity was much greater on the North Fork, where 30 species occurred on 3 or more of the transects; only 16 species occurred on the equivalent number of transects on the East Fork. Important herbs on the North Fork transects were: rig-gut brome (*Bromus diandrus*), golden-aster (*Heterotheca villosa*), creeping bent-grass (*Agrostis stolonifera*), meadow fescue (*Festuca eliator*), horsetail (*Equisetum arvense*), tickle-grass (*Muhlenbergia asperifolia*), blue-grass (*Poa pratensis*) and mesa dropseed (*Sporobolus cryptandrus*). Although herb cover was roughly comparable in the two study reaches, the floristic similarity between the two streams was low. Table 2 provides a detailed breakdown of the cover of those species occurring at least twice on the transects.

Vegetation Structural Differences of the Study Reaches - Figure 5 provides a comparative community cover profile for the two study reaches. On the North Fork, tree cover was 33.0 ± 3.6%, while tree cover on the East Fork was only about one-third as much (11.6 ± 1.8%). Vines were quantitatively unimportant on the North Fork, averaging only 0.7 ± 0.5% cover, but represent an important structural contrast to the vineless vegetation of the East Fork. Shrub cover on the East Fork was more than twice that on the North Fork (at 21.3 ± 2.4% versus 10.2 + 2.1%, respectively). Of the various life-form categories, only herb cover was comparable between the two streams, averaging 20.8 ± 0.9% on the North Fork and 15.9 ± 0.7% on the East Fork.

3.3.2 Results of Relevé Sampling

A total of 19 relevés were sampled at sites in the vicinity of both the North Fork and East Fork transect sites. Some of these relevés were located on tributaries of the two study streams, providing a comparison with the floristic composition of riparian vegetation in a contrasting hydrologic regime. Although limited in scope, the relevé data provides a useful comparison to aid floristic interpretation of the site-specific transect data.

Table 3 provides an association tabulation for the combined floristic data set (cover of species by site) for the 19 relevés and 18 transects. Table 3 was arranged using the COENOS (Ceska and Roemer 1971) algorithm, which simultaneously classifies sites into vegetation associations and species into ecological groups.

3.3.3 Riparian Plant Communities

Two vegetation associations were indicated by application of tabular comparison methods (Mueller-Dombois and Ellenberg 1974), using COENOS and TWINSPAN, to the data set. These associations, herein referred to as community types, are named on the basis of their characteristic dominant and differential species (i.e., those species that serve as indicators of the association).

Figure 5. Histograms depicting the mean (bar height) and standard error (bracket) of plant cover by life-form for the transects in each study reach.

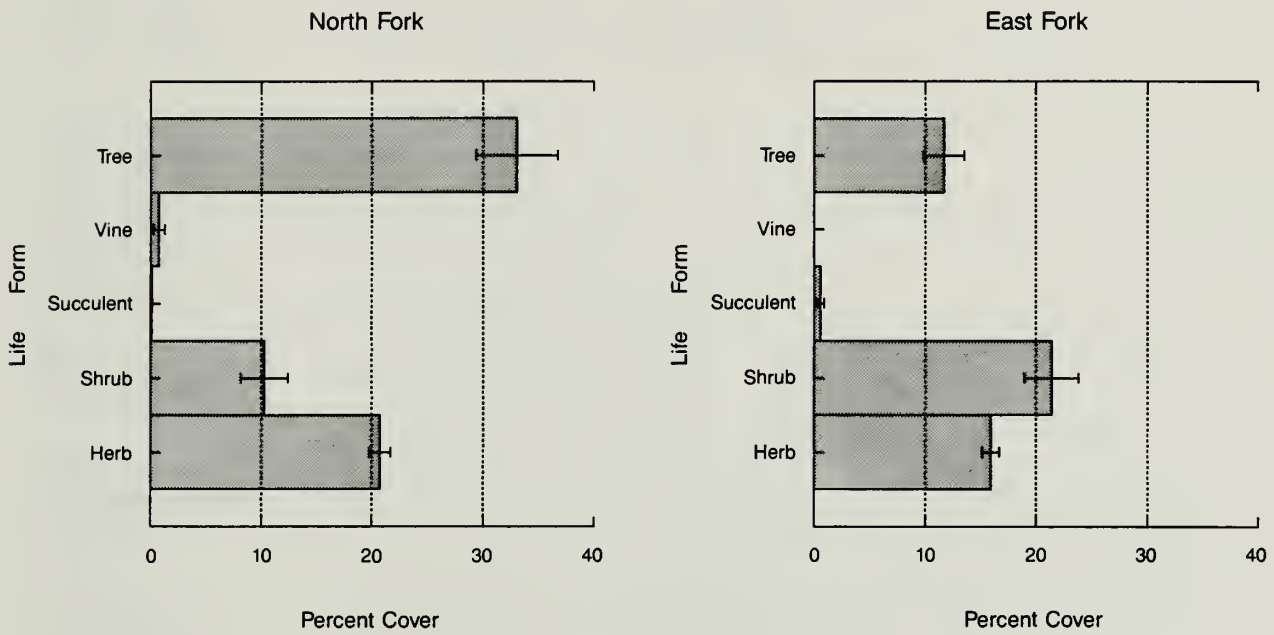


Table 3. Association table for the riparian vegetation in the Zion National Park study area. Cover values correspond to Braun-Blanquet cover classes (see text).

RELEVE OR TRANSECT				T		T	T	T		T	T	T	T	T	T								T	T	T	T	T	T	T		T	T
	R	R	R	R		R	R		R				R							R	R	R	R	R	R	R					R		R	R	
STREAM (North or East)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E	N	E	E	N	N	E	E	E	E	E	E	E	E	N	E	E
TRANSECT NUMBER					7		3	10	4		9	5	6	2	1	8									3	5	2	6	7		4			1	8
Sample No.	1	2	1	5	2	1	3	2	1	2	2	1	2	2	2	2	2	2	9	4	1	1	1	6	7	1	3	3	3	3	3	1	3	1	8	3	3
			7		6	9		2	6	9	3	8	8	4	5	1	0	7		1	2	4			0	2	4	1	5	6	5	3	3		0	7
GROUP 1																																					
Populus fremontii		2	2		3	2	3	2	2		2	2		2		+	2	2	2	3	2	3	2	2	2	2	2	2	2	1	2	2	1	2	2	2
Baccharis emoryi	1	+	r	+	2	+	2	1		2	2	+	+	2	1	2	2	+		2			+	2		1	1	1	2	1		1			2	2
Equisetum laevigatum		1	1	2			+	1		+	+	+	2	+		1	2	1	2	1	1	2	1	+		2	r		1	+	+			+	+	+
Heterotheca villosa		+	+	+	2	2	2	1	r	2	1		2	2	1	1	2	2	r	2	+	1		1	+	+		r		+		+				
Melalotus alba		r			+	+	+			+	r	r		+	+	r			2	+	1	1	+	+		1	+	+	r	+	+	+	+	+		1
GROUP 2		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erigeron sionis	r	r	r		r		r																													
Quercus turbinella	+			r		r																		1							r					
Aquilegia chrysantha	+	r				r		r			r																									
Elymus canadensis			+			+													r												+				
Plantago major		r			r	+																							r							
Quercus gambelii	1		1			r													+																	
Cirsium wheeleri			r			r	+																													
Artemisia dracunculus		+			+									+																					
Phacelia hastata	+	r			r																															
GROUP 3		-		-	-	-	-		-										-																
Vitis arizonica	1	1		+	1		+	+		1		+							1													+			
Verbascum thapsus		+	r	r			r	+		+	1							+																	
Celtis reticulata					1			+		1				+					+																	
		-		-	-	-	-	-		-									-																	
GROUP 4		-	-				-		-											-																
Solidago canadensis		1	r				r		r											r				r	+						1				
Haplopappus scopulorum							+		+		+								+																	
Salix goodingii		1										2								+								1								
Carex hystricina			+						1										+																	
		-	-				-		-											-																
GROUP 5			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-																
Fraxinus velutina	3	3	3	1	2	2	2		1	2	1	+	2		2	2		2		1				2												
Acer negundo	1			3	2	1		2	+	2	2	+	3	2	2	1	2	3	+						r											
Tamarix ramosissima			+		+	r	2	1	r		2	r	1	+	2	3	1	+		+	+		r													
Senecio spartioides	+		+	+	+	1	1			1			1		+	+	r	+		1							+			r					
Equisetum arvense				+		+	+	+	+				1		+	1	+		+	r				+										r	+
Bromus diandrus				1	2		+	2		1	2		2	3	2	2	2	3		4																
Oenothera longissima			r	r		r	r	r			r	r		+		r			r		r	r				r									
Festuca eliator					1			1		1	2		1	+	1	1	1	1																		
Agrostis stolonifera		1	+	2	2	1	2	1	+		2	+	1	1	2	2	1							2				r			r		1		
Juncus ensifolius mont.		+	1			1	1	+	1			r				+	+				1		r								+				
			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-																
				-	-	-				-		-				-																			
GROUP 6							-	-	-			-			-	-	-			-																
Muhlenbergia andina			1	+		+	+		1			+		+	r			2	+														+			
Aster ascendens	+	1				r			1		r	+			r	r				r																
Artemisia ludoviciana	+		+				r			r		r			+	+				+															1	
Ranunculus cymbalaria						+	1	+				+			+	+				r				r												
Conyza canadensis						r	+	r		r		+			r	+		r																		
Agropyron trachycaulum						+			1					1	+	1	1			r																r
Typha domingensis			r			+				+					+					r	+							r							
Baccharis glutinosa				+	+	r	2				+		2							r																
Mentha arvensis						+	r				+	+							+	r				r												
Poa pratensis					2		1			+	+		+			+	1																			
Erigeron divergens						r	r			r			r		r					r																
Juncus ensifolius brun.					1						1					+			2	+				r												
Euthamia occidentalis									+	r	r				r	+				r																
Medicago lupulina					+										+	r				r												+			
Melalotus officionalis					+	r									r	+																+			
Erigeron flagellaris			+		r	+									+																				
Trifolium repens					r	1					+								+																
Cirsium vulgare					r	r													r																
Festuca pratensis					+	1													+																
Polypogon monspeliensis					r	+													+																
Verbena bracteata						r					+								r																
Plantago lanceolata					r	r													r																
Carex nebrascensis					r	r													r																
					-	-	-				-		-						-																

Table 3. Continued.

RELEVE OR TRANSECT				T		T	T	T		T	T	T	T	T	T															T	T
STREAM (North or East)	R N	R N	R N	N	R N	R N	N	R N	N	R N	N	N	N	N	N	N	R E	R E	R E	R E	R N	R N	R E	E	E	E	E	E	R E	E	R E	R E	N	E	E
TRANSECT NUMBER				7		3		10	4		9	5	6	2	1	8								3	5	2	6	7		4			1	8
Sample No.	1	2	1 7	5	2 6	1 9	3	2 6	1 9	2 3	1 8	2 8	2 4	2 5	2 1	2 0	2 7	9	4	1 1	1 2	1 4	6	7	1 0	3 2	3 4	3 1	3 5	3 6	1 5	3 3	1 8	3 0	3 7
GROUP 7									-				-	-																				
Melalonus indica							+	+	+				+	r							r							r						
Sonchus aspera									r				r		r																			
Epilobium ciliatum											r			r			1																	
Elymus elymoides									r				r	+																				
									-				-	-																				
GROUP 8			-		---				-------				----------																-----					
Muhlenbergia asperifolia			+		+ 1				+ + + 2				1	2	+	1	2	2	2	1	3	1	1	+	+				+		+		r
Machaeranthera tanaceti					r						+		+				+		r			+		+	+	1		+	+	+	+			
Juncus balticus			+	1			1				r	+	1	+			+		2	+	+									+		+		
Poa glaucifolia		+					+	r	r	+		+	+	+	+	r																		
Scripus microcarpus			+		r r					+		1	r	+					+	r			+					r						
			-		---				-------				----------																-----					
GROUP 9																	-		-----															
Rhus trilobata																	1		+	1	r								1					
Sorgastrum nutans																			1	1		+		1							1			
Yucca angustisissima																			+	r			+	+				1						
Astragalus ensifolius																	r				r			r							+			
Juniperus scopulorum				1				+											+	1														
Aster hesparius		+															2		+												+			
Castilleja linariifolia	r																		r	r														
Clematis ligusticifolia											+						+				r													
Fraxinus anomola																			r		r							1						
Gllyceria lepidota																	+		r	1														
																	-		-----															
GROUP 10					---		-				----------								-			-					----------						-	
Sporobolis cryptandrus				1	1 2			1		+	1	1	+	1	+			1	r			+				1	1	1	r		+	+		1	
Sporobolis contractus					1 +	1		1		+	1	+	+	1	2			2				1				+	1	1	1	+		r	1		1	
Bromus tectorum			+			r	+		+				1	r	1	1		+								2	2	2	2	2	2	2	3		2	2
						---			-			----------						-				-													-	
GROUP 11						-		-					-					----------					---				----------						---	
Salix exigua						r		+			+			r				r	1	1	1	+	1	1	1		1	2	1	2	+	1	r	2	1
Scirpus pungens				+										+			2	+	2	2	1	1			1	1	1	1	+	1	1	+		+	1
Opuntia phaecantha						r	+	+					+				1	r	1	1	1			1						1	+	1		1	
						-		-						-				----------					-	-				----------						---	
GROUP 12																		---		-----		-								-----				
Juniperus osteosperma																		r	1		+	+	1		1		+					2	1	1
Aster glaucioides																	+	r	+		+	+	1							r	1			
Ipomopsis congesta fruct.																		r	r	r					+		1			+		r	
																		---		-----		-								-----				
GROUP 13																										----------						---	
Chrysothamnus nauseosus																			2	2	r	1		1	2	2	2	2	2	2	2		2	1
Aristida longiaristata									+									+						1	1	1	+	+	+	1	r		1	1
Oryzopsis hymenoides						r				+								r					+	r	+		r		+	1	+	1		1	
Gutierrezia microcephala						+							r						r	+	+		+			1		1	+		+	r			
Oenothera pallida	r														r				r	r						r		r		+	+	r		+	
Mosses									1			1				1										1	2	1	+		1			1	+
Ambrosia acanthocarpa																					r			r		+	+		r	+	+	r		+	r
Psoralea lanceolata																					+				2	1	1	2	2		1	3		1	1
Sporobolis flexuosus								1			+									+							2	2	1		1			2
Linum aristatum																									r	r	+			+	+	r		r	
Artemisia filifolia																									1	1			1	r	1	+		1	
																										----------						---	
GROUP 14																													-----					
Munroa squarrosa																										+		+		r	1				
Eriastrum sparsiflorum																											r			r	r			+	
Purshia tridentata																														r	1			+	
Limus australe																			r											+		+			
Astragalus miser																															r			r	+
Townsendia incana																												+			r	r			
																														-----				---	

The two community types are:

Populus fremontii-Fraxinus velutina community

Populus fremontii-Salix exigua community

The *P. fremontii-F. velutina* community type is characterized by the species of Group 1 (Table 3), specifically *P. fremontii, Baccharis emoryi*, seep willow (*Equisetum laevigatum*), scouring rush (*Heterotheca villosa*) and sweet-clover (*Melilotus alba*). Differential species that serve to specifically identify stands belonging to this type are those of Group 5 (Table 3), namely *F. velutina, Acer negundo, Tamarix ramosissima,* groundsel (*Senecio spartioides*), *Equisetum arvense*, *Bromus diandrus*, evening-primrose (*Oenothera longissima*), *Festuca eliator*, *Agrostis stolonifera* and rush (*Juncus ensifolius* var. *montanus*). Stands of the *Populus fremontii-Fraxinus velutina* community vary considerably in their understory, but the floristic composition of the overstory is relatively uniform (cf. Table 3). Species of Group 3 (Table 3) are the only woody species that occur on a subset of the stands of this community: western hackberry (*Celtis reticulata*) occurs sporadically as a riparian tree, occurring most often only on the margin of the Riparian Zone, while *Vitis arizonica* is more frequent in some stands of this type, where it climbs as a large vine into the crown of *Acer negundo* or *C. reticulata*.

The species of Group 6 (Table 3) are chiefly herbs that typically occur on moist, fine-textured bars or on the moist margins of the active channel. In some stands, this herb guild is quite diverse, with some 20 species occurring. Other sites, those generally lacking moist bars in the channel, have only a fragment of this group of species. Similarly, the species of Group 2 (Table 3) that occur sporadically on mid-channel bars or on moist margins of the active channel are typical of the moist seepage sites of nearby cliffs (termed 'hanging gardens').

Group 8 (Table 3) is a collection of herbaceous species that occur on both the North Fork and East Fork of the Virgin River. These taxa occur together in moist, sandy, semi-alkaline microsites where groundwater seepage through fine sediments is evident, as indicated by the presence of surficial evaporite deposits (salts) coating the ground. By contrast, the species comprising Group 10 (Table 3) occur on dry, sandy terrace soils within the Border Zone. This group is also present on both forks of the Virgin River within the Park.

The *Populus fremontii-Salix exigua* community is characterized by Groups 11 through 14 (Table 3). Sandbar willow (*Salix exigua*) is more frequent on the East Fork, but does occur sparingly on the North Fork. This willow is characteristic of sandbars with high-soil moisture (usually in direct hydrologic contact with the stream) in sites that are regularly disturbed by flooding.

The species of Groups 12 and 13 (Table 3) are in general upland, desert species that occur within the Riparian Zone. This pattern reflects a major floristic and structural difference in the vegetation between the two forks of the Virgin River in Zion National Park: desert shrub and herbs are infrequent on the North Fork, whereas they comprise a notable segment of the Riparian Zone vegetation on the East Fork.

Table 4 provides the results of TWINSPAN classification of the combined relevé and transect data set. Careful comparison of Table 3 with Table 4 indicates that the principal pattern of differentiation indicated in the COENOS analysis is corroborated by the TWINSPAN analysis. Analysis of the floristic data set using the contrasting methods of agglomerative and divisive classification yielded similar results: two groups of stands, which can be recognized as community types. The correspondence of classification structure produced by the two contrasting analysis methods indicates that the pattern of differentiation within the data set is not likely an artifact of analysis methodology. Rather, it represents a real ecological difference in vegetation structure.

Table 4. Results of TWINSPAN classification of riparian vegetation in the Zion National Park study area. Two classes of vegetation were identified by the analysis (sample numbers correspond to the header in Table 3).

	2222222222 1 111 11113333333311 5789013524634912678789601240571234635
Salix lasiolepsis	----------1----5----------
Quercus gambelii	----------1--3--2---1----------
Quercus turbinella	----------11--1----21----------
Aquilegia chrysantha	----------1--111-1----------
Vitis arizonica	1--1----1-21--32--1-12----------
Solidago canadensis	----------1---211-12--11----------
Erigeron sionis	--------1----111-1----------
Aster hesparius	----------1--14--1----------
Muhenbergia andina	1-1--1-1---111--22--14----------
Juncus ensifolius mont.	--2--1------12-------41----------
Fraxinus velutina	3444-323--3434552514----------
Carex nebrascensis	----------111----------
Baccharis glutinosa	----------111----------
Festuca pratensis	----------311----------
Poa pratensis	--11211---43----------
Bromus diandrus	2552443445415----------
Euthamia occidentalis	--1-111-----1-----1----------
Erigeron divergens	-----11-11-11----------
Celtis reticulata	---2----111----------1----------
Festuca eliator	-1222232212----------
Sitantion jubatum	-----111---1----------
Acer negundo	55533134344--23-1-1--1-1----------
Tamarix ramosissima	-11-2534211411--111---1-1----------
Baccharis glutinosa	--1----43-1----------
Poa glaucifolia	-1111111--1------11--1----------
Agyopyron trachycaulum	-2-111-2---11----------1-------
Ranunculus cymbalaria	--1-11--1--211--------1----------
Equisetum arvense	1-2-11-11--111--1----11----1-1-------
Heterotheca villosa	14443222233553-111-1-13112--1---11---
Artemisia ludoviciana	--1-111----------1---------
Mentha arvensis	--1-1------111----1--11----------
Agrostis stolonifera	3-1-23432245-2-3111-2-4----------1--1
Baccharis emoryi	1113434124354121-115--1----33422122--
Sporobolis cryptandrus	-11-212131223---------1-1--21-1211--1
Typha domingensis	-----11----11----1------1----------1
Salix goodingii	---------3-----2--------1---------1--
Oenothera longissima	1----11-11-1-1---11--1-111----------
Equisetum laevigatum	3231321-11-12--2-21-141434211111--1--
Scripus microcarpus	----11-1---1-1---11----111----------1
Scirpus acutus	----------1-1----------1-
Juncus ensifolius brun.	----11--1--2-2-1221-----2-1---------1
Juncus balticus	-1--1121---211--------1--511-------1-
Muhlenbergia asperifolia	-131321----341---1121352442--1-111---
Sporobolis contractus	-31121-112-142--------2----22-211212-
Populus fremontii	-3--413-335554-5455444445544344434234
Phragmites australis	----------2--4----------
Gutierrezia microcephala	-------1---1----------1111-1---1111-
Oenothera pallida	----1----------1--------11--11--11-11
Scirpus pungens	-----1------11-------42-4531222212113
Fraxinus anomala	----------1-1-------2--
Salix exiguua	-----1-----11---1-121-12223332121-124
Chrysothamnus nauseosus	----------2-4413324133454
Munroa squarrosa	----------1---21--1
Aristida longiaristata	------1-----1----------2122112111
Psoralea lanceolata	----------1132232235-
Artemisia filifolia	----------2-122211
Sporobolis flexuosus	--12----------1--33----322
Bromus tectorum	-2-121-21--11----1---------3335433354
Oryzopsis hymenoides	----------11-----11---1---1--111-122
MOSS	-222----------2213-221--

The primary differentiation in the vegetation is into two community types associated with the two study streams. Samples from the North Fork are generally *Populus fremontii-Fraxinus velutina* vegetation, while samples from the East Fork support *Populus fremontii-S. exigua* vegetation. These differences likely reflect differing hydrologic and geomorphic conditions between the two watersheds, and are not simply a geographic differentiation. Samples of the *Populus fremontii-Salix exigua* community type occur on Pine Creek, a lower-order, largely ephemeral tributary to the North Fork Virgin River. *Populus fremontii-Fraxinus velutina* vegetation, by contrast, was not encountered on the East Fork, although some species typical of this community type were encountered in a stand along Shunes Creek, a tributary to the East Fork (cf. relevé 9 of Table 3).

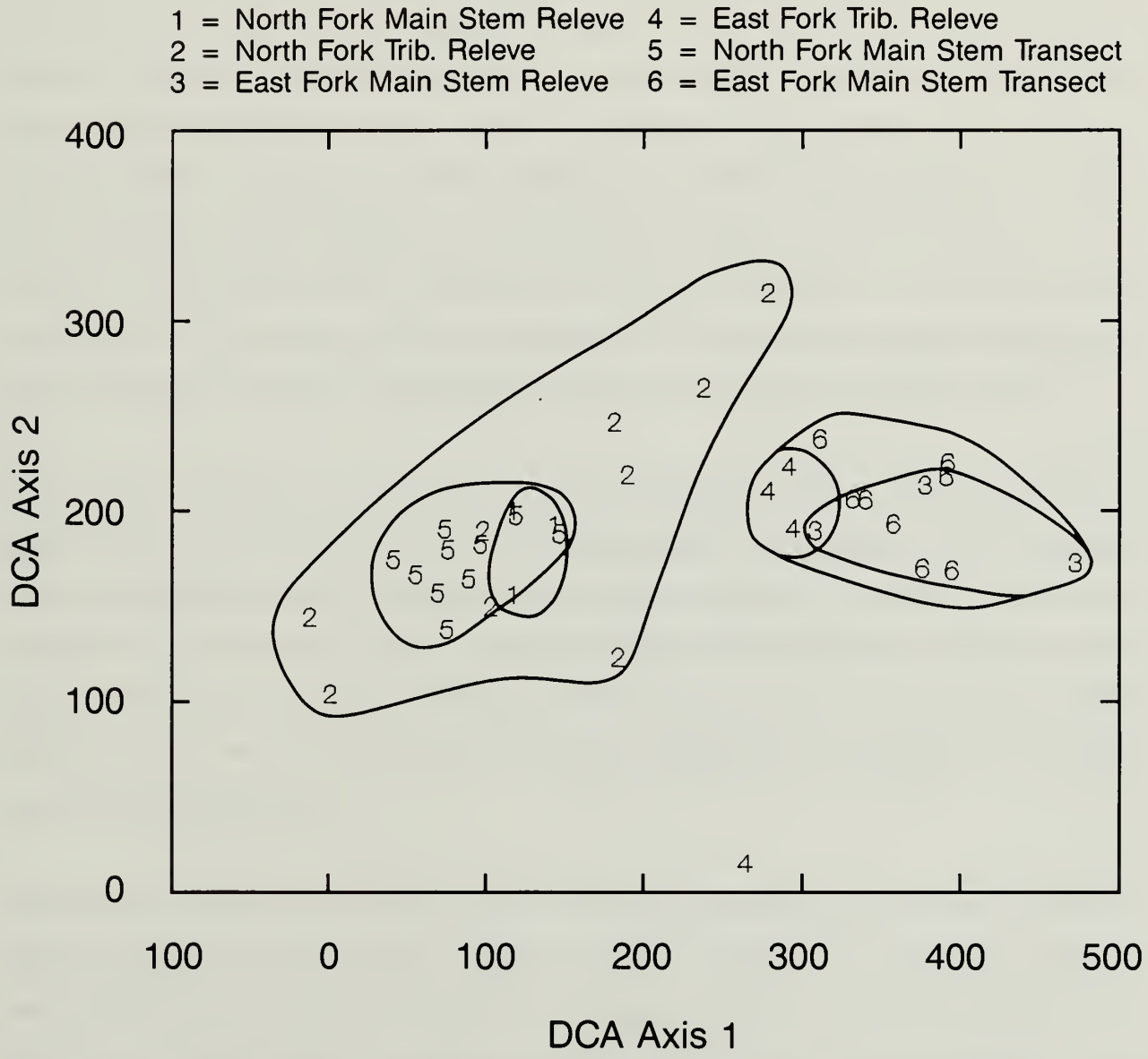
3.3.4 Ordination Relationships of the Vegetation

Detrended Correspondence Analysis (DCA) ordination of the combined transect and relevé data set is depicted in Figure 6. Only the first two axes of variation are shown, which account for 64% of the total variation in the ordination eigenvalues. The two suites of transects fall out in the ordination diagram into two clusters. Relevés sampled upstream or downstream from the transect study reaches ordinate in close proximity to their transect counterparts. Relevé samples on tributaries, however, ordinate along the second DCA axis, indicating their greater degree of vegetation heterogeneity as compared to the main-stem stream samples.

The ordination analysis indicates that the study reaches are not markedly different in vegetation structure from other reaches upstream or downstream. Based on the results of this analysis, extrapolation from the results of detailed study of only one reach on each stream is justifiable on the basis of overall vegetation structure.

Figure 7 represents a dendrogram resulting from cluster analysis of the between-sample dissimilarity matrix. Dissimilarity values between possible pair-wise combinations were

Figure 6. Detrended Correspondence Analysis (DCA) ordination of 37 transect and relevé samples from the Zion National Park study area. Two groups of samples are evident in the ordination field, roughly corresponding to sites from the North Fork and East Fork of the Virgin River.

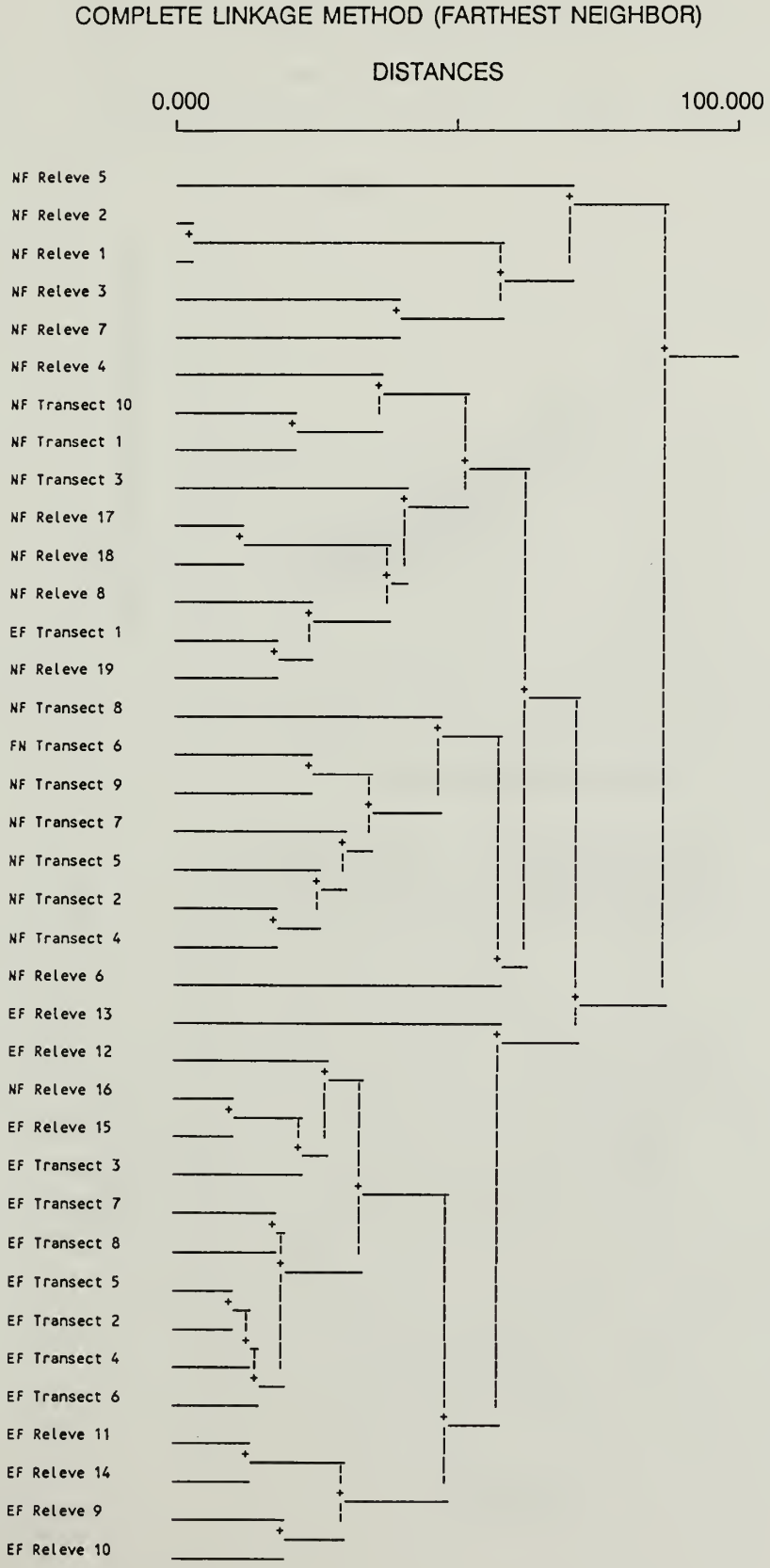


made using Euclidean distance (Whittaker 1980). Linkage between stands was made using the farthest-neighbor method (Wilkinson 1987). Three groups of samples are evidenced in the dendrogram (at a dissimilarity of 70%). The small group of five relevés at the top of the figure are floristically depauperate tributary stream sites that fall as outliers in both the DCA ordination (Figure 6) and in Table 3. Discounting placement of these stands, the dendrogram again reproduces two groups of samples, corresponding largely to East Fork transects and relevés characterized by the *Populus fremontii-Salix exigua* community, and North Fork transects and relevés corresponding to the *P. fremontii-Fraxinus velutina* community. Cluster analysis of the floristic data set largely reproduces the pattern detected by COENOS and TWINSPAN analysis, with several exceptions (i.e., Transect 1 on the East Fork is classified with the North Fork relevé and transect group, see Figure 7). Inspection of Table 3 indicates that Transect 1 was poorly developed in that component of the flora characteristic of the North Fork of the Virgin River.).

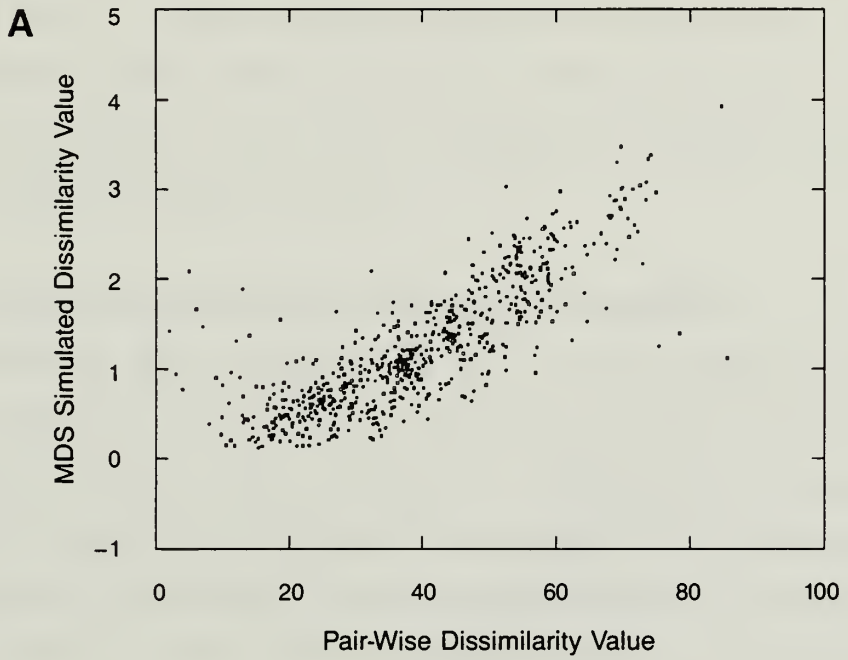
Figure 8A represents the results of multi-dimensional scaling (MDS) analysis of dissimilarity values calculated between all stands (relevés and transects). MDS seeks to locate each sample in the ordination array in such a way that its relative position is a function of its dissimilarity. Figure 8A provides a plot of the MDS values (on the first two axis) as a function of intrastand-dissimilarity. From this plot, it can be seen that the MDS analysis of the data set was largely successful at graphically representing the between-sample dissimilarity matrix.

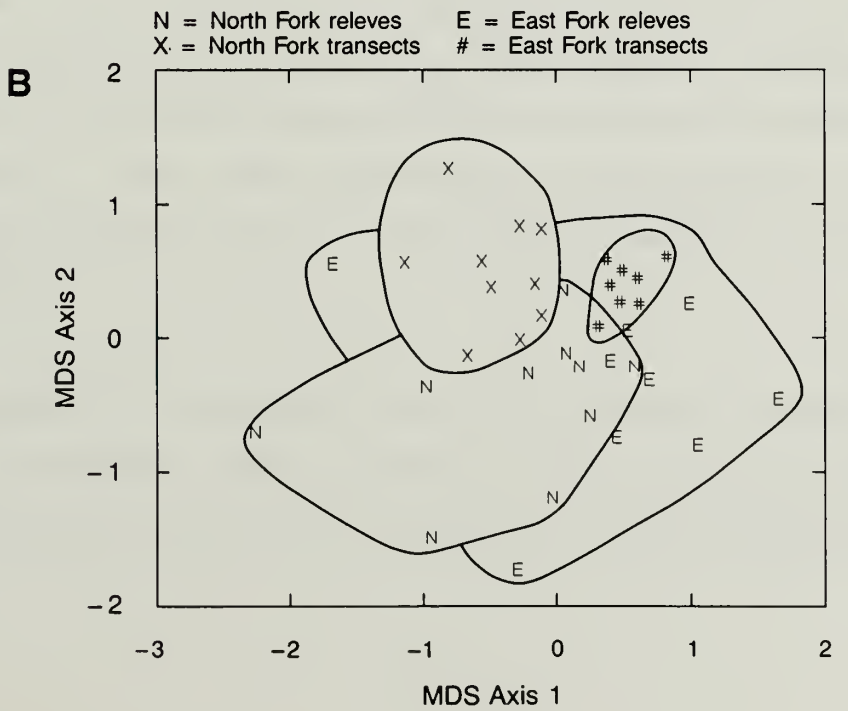
Separation of the data set along the first MDS axis (Figure 8B) corresponds to the two community types and watersheds, as discussed above. The order of samples along the second MDS axis corresponds to a gradient of floristic richness - since fewer species were encountered using transect and quadrat sampling, all the transect samples ordinate to the right in the diagram.

Figure 7. Dendrogram depicting the results of cluster analysis of dissimilarity values (based on Euclidean distance) between transect and relevé samples from the Zion National Park study area.



Figures 8. Multi-dimensional scaling (MDS) ordination of the relevé and transect sampling sites. Floristic dissimilarity was calculated between all stands using Euclidian distance. The top plot (A) depicts the relationship between the observed floristic dissimilarity values and the MDS modeled values. The bottom figure (B) provides the resultant ordination. Note in the ordination that the transect and relevé sites are distinguishable for the two study streams, reflecting the divergent floristic differences discussed in the text.





3.3.5 Diversity Characteristics of the Vegetation

Diversity indices were calculated for each transect and relevé sample using two methods (Barbour et al. 1987): Simpson's index and the Shannon-Wiener information index (H') (Table 5). For each index, both richness and evenness components were determined. Consideration of Table 5 shows that diversity exhibited a great range between sites. In general, both relevés and transects on the North Fork exhibited slightly higher diversity than the East Fork. A secondary pattern evident in the diversity data is that transects, in general, exhibited higher diversity than relevés. This result is related to the respective bias of the two sampling methods, in that a species has a different probability of being sampled on transects compared to relevés.

3.3.6 Comparisons with other Regional Vegetation Classifications

The two community types recognized in this study are similar to riparian plant communities described throughout the southwestern United States. Using the comprehensive classification system of Brown et al. (1979), the two community types can be considered to represent the regional formation (Type 223.2), Southwestern Riparian Deciduous Forest and Woodland. Although riparian vegetation in the Park, particularly on the North Fork, is a mixed stand of *Populus fremontii, Acer negundo* and *Fraxinus velutina* in nearly equal proportions, the vegetation is best placed in the Cottonwood-Willow Series (type 223.21) of Brown et al. (1979). Within the classification system of Cowardin et al. (1979), riparian communities in the Park would be considered Palustrine, Forested Wetland. Szaro (1989) recognized both a *Populus fremontii* Community Type and a *Salix exigua* Community Type in a recent riparian classification system for Arizona and New Mexico.

Riparian vegetation in southwestern Utah has not received extensive synecological treatment in the literature. Riparian vegetation at lower elevations or latitudes in the Southwest (principally Arizona) has been described (Gary 1965; Campbell and Green 1968;

Table 5. Summary of diversity comparisons for the study reaches. Diversity indices calculated correspond to those discussed in Barbour et. al (1987). Mean and standard error are given.

Stream	Number of Species	Richness		Evenness	
		Simpsons Index	H'	Simpsons Index	H'
East Fork					
Relevés	22.0±1.5	0.85±0.01	2.15±0.09	0.28±0.006	0.69±0.021
Transects	20.8±0.8	0.89±0.008	2.38±0.04	0.29±0.003	0.78±0.010
North Fork					
Relevés	21.5±2.1	0.69±0.04	1.68±0.11	0.23±0.013	0.55±0.03
Transects	25.9±2.4	0.88±0.01	2.40±0.06	0.27±0.007	0.75±0.01

Hasse 1972; Reichenbacher 1984; Paxson 1981; Rucks 1984). However, vegetation at more northerly latitudes or higher elevations in the region, is poorly documented in the literature. Irving and West (1979) described riparian vegetation along the lower Escalante River in Utah.

3.4 Size-class Distribution of Riparian Trees

Data on the diameter of tree species was collected along belt-transects at the 18 transect sampling sites. Data was obtained for 1083 trees: 682 on the North Fork and 401 on the East Fork. Tree diameter and age are often roughly correlated, particularly for rapidly-growing, short-lived species like *Populus fremontii* (Asplund and Gooch 1988) and *Tamarix ramosissima* (Brotherson et al. 1984). The specific degree of correlation, if any, between age and diameter has not been determined for the principal riparian trees of the study area. It can, however, be assumed that relative differences in the diameter-distribution characteristics of a stand or site can be taken to reflect relative age differences.

Figures 9 and 10 provide histograms showing the frequency distribution of stem diameter by 10 cm (4 in) diameter classes for *Populus fremontii, Acer negundo* and *Fraxinus velutina*. The diameter distribution for *Populus fremontii* differs on the two study streams (Figure 9). The distribution on the East Fork is regular in shape, being characteristic of a 'reverse-j' type of population (Harper 1977) in which the proportion of individuals in each size category declines incrementally, possibly due to a relatively constant probability of mortality (Hutchinson 1978). By contrast, the diameter distribution of *Populus fremontii* on the North Fork is skewed and irregular. The greatest proportion of individuals are in the smallest diameter class, and some diameter ranges lack representation.

Interpretation of the observed differences in diameter distributions for the two study streams will require analysis of hydrologic and sediment transport data. Studies underway by the NPS will be providing this data, which will be analyzed in the final report.

Figure 10 provides histograms depicting the diameter distribution for *Fraxinus velutina* and *Acer negundo* on the North Fork (these species were absent from the East Fork). *Fraxinus velutina* exhibits an irregular distribution, like that of *Populus fremontii*, while the diameter distribution of *A. negundo* is more characteristic of a stable-age population.

Figure 11 provides probability plots of the diameter distribution for *Populus fremontii* on the two study reaches (a probability plot, Tukey 1977, is a method of characterizing the statistical shape of a distribution). In Figure 11A, the diameter distribution of *P. fremontii* on the East Fork follows a log-normal distribution. Log transformation of the data from the North Fork did not normalize the distribution. The North Fork size distribution, by contrast, follows a powered-exponential (Weibull) distribution (Figure 11B).

Figure 9. Histogram depicting the proportion of stems by diameter class for *Populus fremontii* on the two study streams.

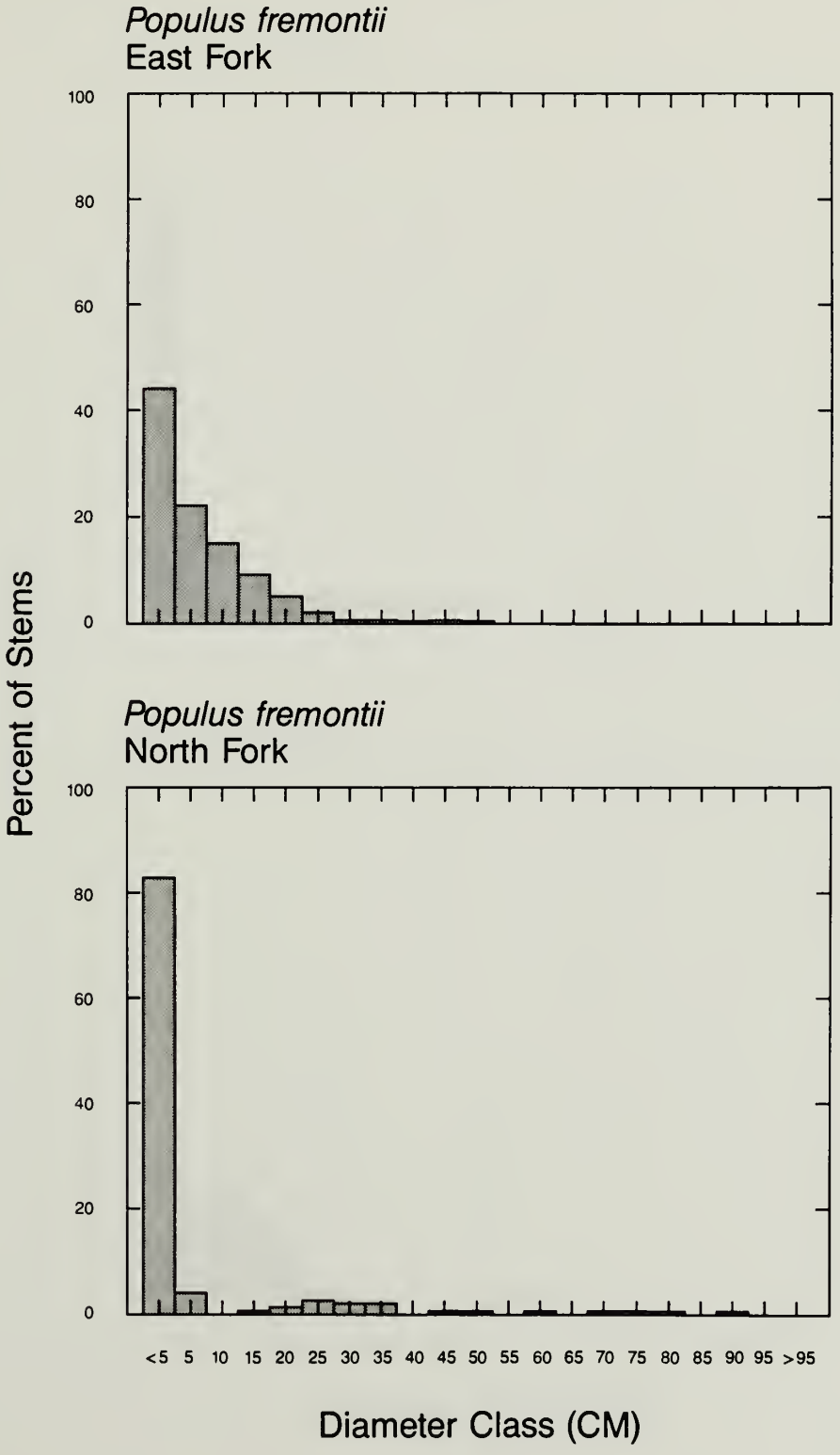


Figure 10. Histogram depicting the proportion of stems by diameter class for *Fraxinus velutina* and *Acer negundo* on the North Fork study stream (these species were absent from the East Fork study stream).

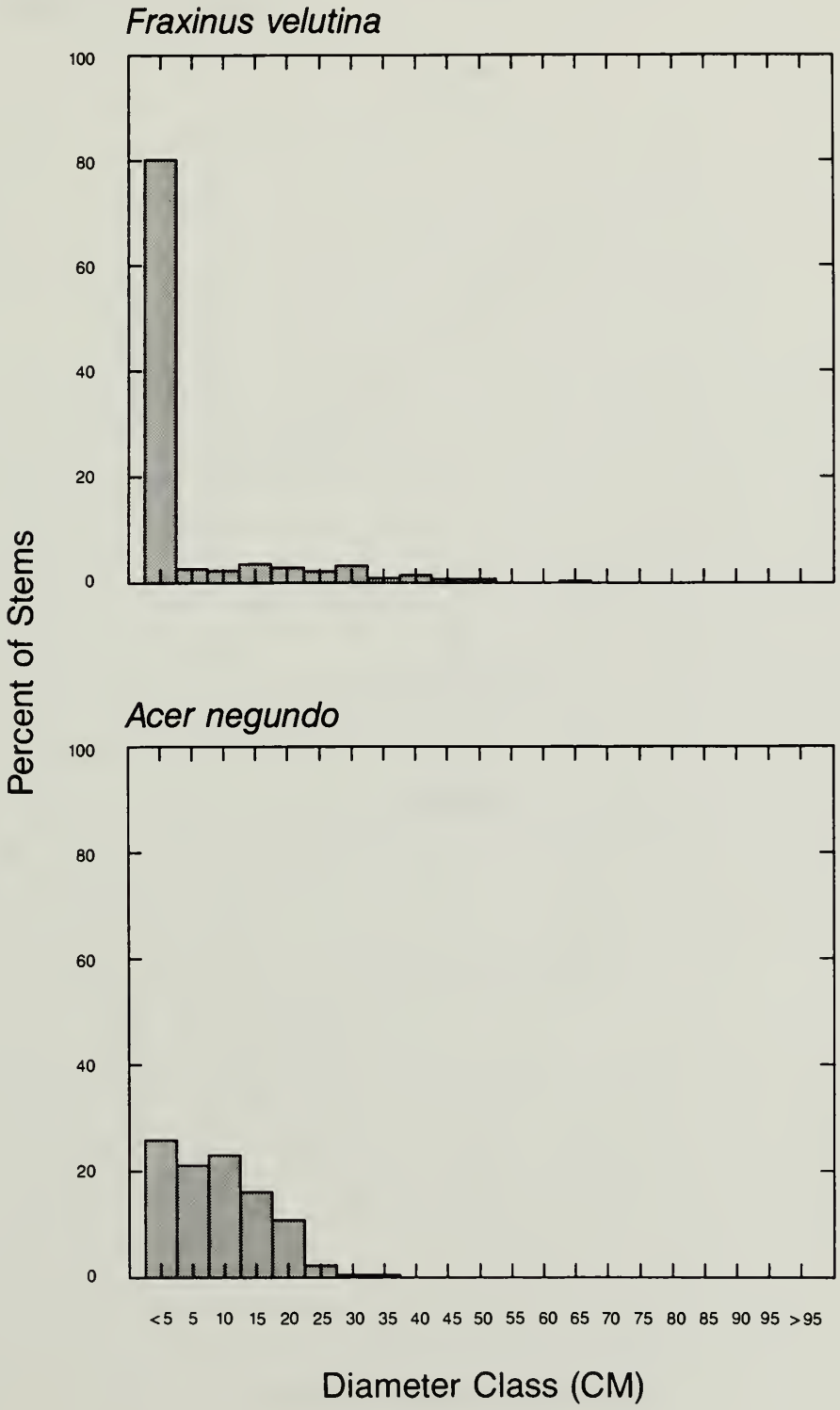
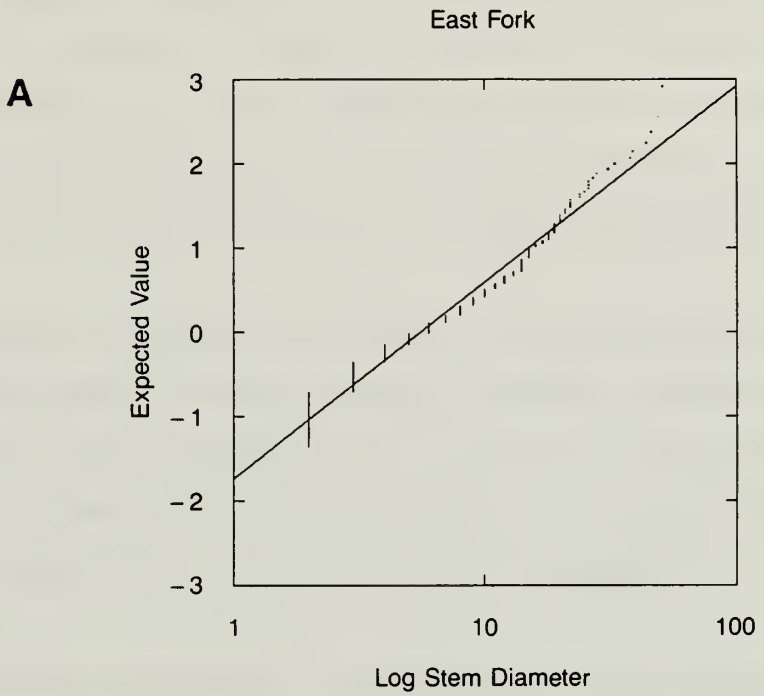
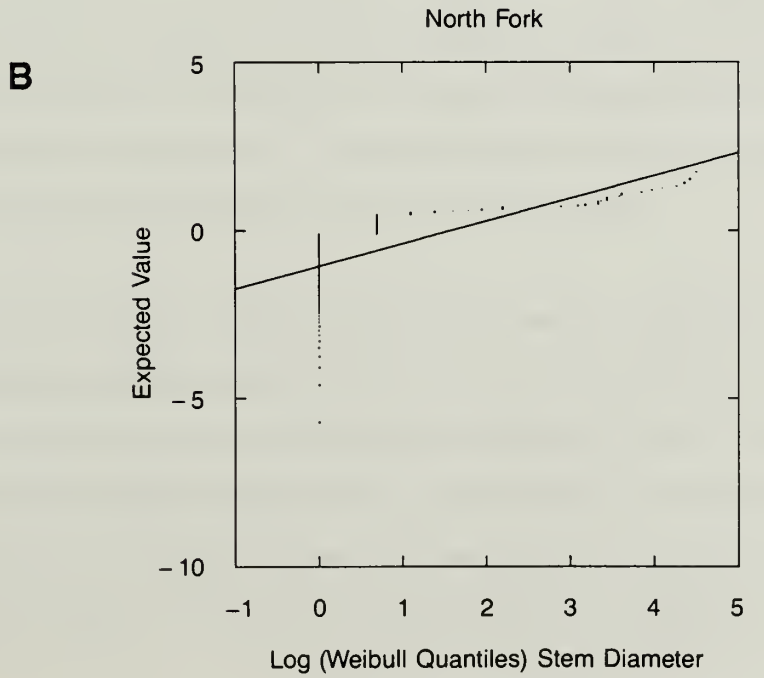


Figure 11. Probability plots (Tukey 1977) characterizing the shape of the size-class distributions for *Populus fremontii* on the two study streams (Fig. 11A for the East Fork, Fig. 11B for the North Fork). In each figure, a solid line is plotted that indicates the expected values based on the type of distribution indicated.





3.5 Riparian Zone Position of Dominant Species

The preceding discussion provides a description of the composition and structure of riparian vegetation in the study area. Understanding the potential response of riparian vegetation to modified streamflow is part of the second phase of this research effort. Modeling the response of riparian vegetation to modified streamflow requires generalizations that can be used to characterize ecosystem responses. Understanding the behavior of dominant riparian trees, using inferences derived from the literature, will be a focus of the later phases of this research pending availability of hydrologic data.

Table 6 provides a breakdown of the location of seedlings, saplings and adult trees for the two study reaches. For this comparison, 'seedlings' were arbitrarily classified as all stems <5 cm (2 in) dbh; saplings were >5 cm and <10 cm (4 in) dbh. Mid-channel bars are sediment deposits within the active channel that are not inundated during summer base-flow conditions, and are hence available for plant growth.

On the North Fork, seedlings of *P. fremontii* occurred most frequently in the Active Zone (in the active channel or on mid-channel bars), whereas seedlings on the East Fork were more frequent in the Border Zone (on floodplain terraces outside the active channel). The differential position of seedlings between the two study reaches is consistent with their differing size-class distributions. Seedling recruitment on the North Fork seems to be more uniform in spatial distribution than on the East Fork.

Seedlings of *Acer negundo* and *Fraxinus velutina* on the North Fork were more frequent in the Border Zone than the Active Zone, whereas the adult trees of these two riparian species are of equal abundance throughout the Riparian Zone. This contrast is likely due to differential mortality: seedling survival is higher closer to the stream channel. Seedlings of single-leaved ash (*Fraxinus anomala*), a non-riparian tree that also occurs on the lower slopes of Zion Canyon, was found on mid-channel bars within the active channel, but the

Table 6. Riparian Zone position of seedlings, saplings, and adult trees as a function of stream channel geomorphology.

Stream	Sample Size	PERCENT OF OCCURRENCES North Fork Channel	Bar	Terrace	Sample Size	East Fork Channel	Bar	Terrace
Species								
Acer negundo								
Seedlings	n = 25	-	4.0	96.0				
Saplings	n = 36	50.0	-	50.0			Absent	
Trees	n = 152	52.0	-	48.0				
Fraxinus anomola								
Seedlings	n = 64	-	78.1	21.9			Absent	
Fraxinus velutina								
Seelings	n = 275	22.2	-	77.8				
Saplings	n = 12	66.7	-	33.3			Absent	
Trees	n = 69	68.1	-	31.9				
Populus fremontii								
Seedlings	n = 90	23.3	46.7	30.0	n = 20	16.7	-	83.3
Saplings	n = 36	36.1	58.3	5.6	n = 115	41.7	-	58.3
Trees	n = 25	40.0	-	60.0	n = 143	31.5	-	68.5
Tamarix ramosissima								
Trees	n = 13	84.6	-	15.4			Absent	

Note: Channel and Bar refer to the active channel and gravel bar portions of the Active Zone. Terrace refers to the terrace landforms portion of the Border Zone.

adults of this species were absent within the Riparian Zone. Most likely, these *F. anomala* seedlings do not survive inundation, and hence these trees typically do not become established in the Riparian Zone. This observation is of ecological interest, for it suggests that the effects of modified streamflow on these reaches may involve the colonization and establishment of native yet non-riparian taxa (paralleling the saga of the invasion of exotic *Tamarix* and other non-native taxa in riparian habitats throughout the West).

Figures 12 and 13 provide histograms depicting the position of the three dominant riparian trees on the study streams in relation to the thalweg (deepest portion of the channel). Because of differing stream channel characteristics and riparian zone widths on both the transects and study streams, the data in these figures have been relativized by taking the proportional distance from the thalweg. For *Populus fremontii* on the North Fork, the majority of seedlings and saplings occur relatively close to the thalweg, whereas the majority of adult trees are relatively far from the thalweg. On the East Fork, seedlings and saplings of *P. fremontii* occur relatively close to the thalweg, but adult trees occur over a wider range of positions than on the North Fork. These data are consistent with the observations on the differences in size-class distribution (Figure 9), and seedling position (Table 6) between the two study streams. On the North Fork, seedlings of *Acer negundo* and *Fraxinus velutina* occur farther from the thalweg than do seedlings of *P. fremontii* (Figure 13).

Figure 12. Histogram depicting the location of individuals of *Populus fremontii* seedlings, saplings and adult trees for the two study reaches. The distance of a particular tree from the thalweg (deepest portion of the channel) was relativized by making the data proportional to transect length.

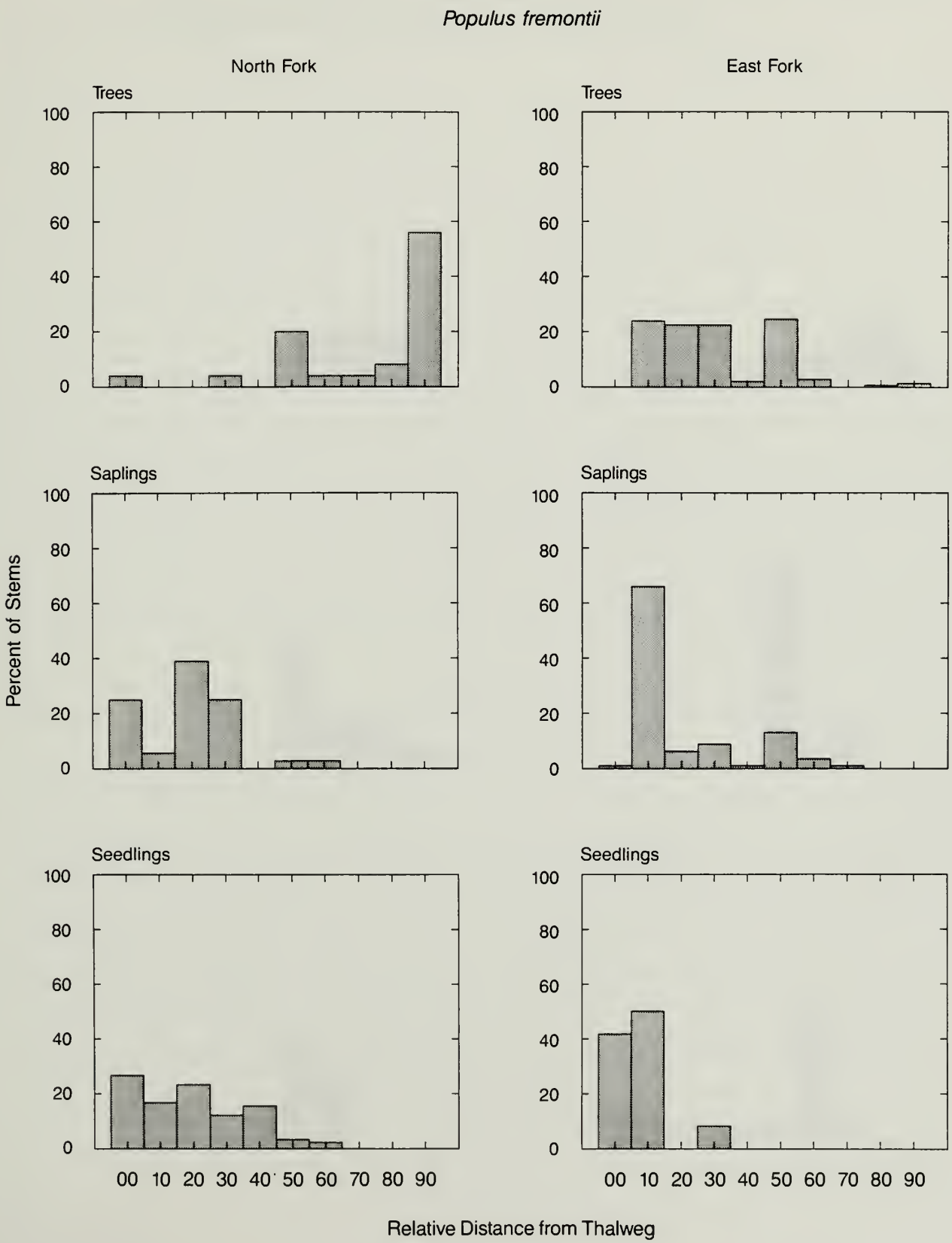
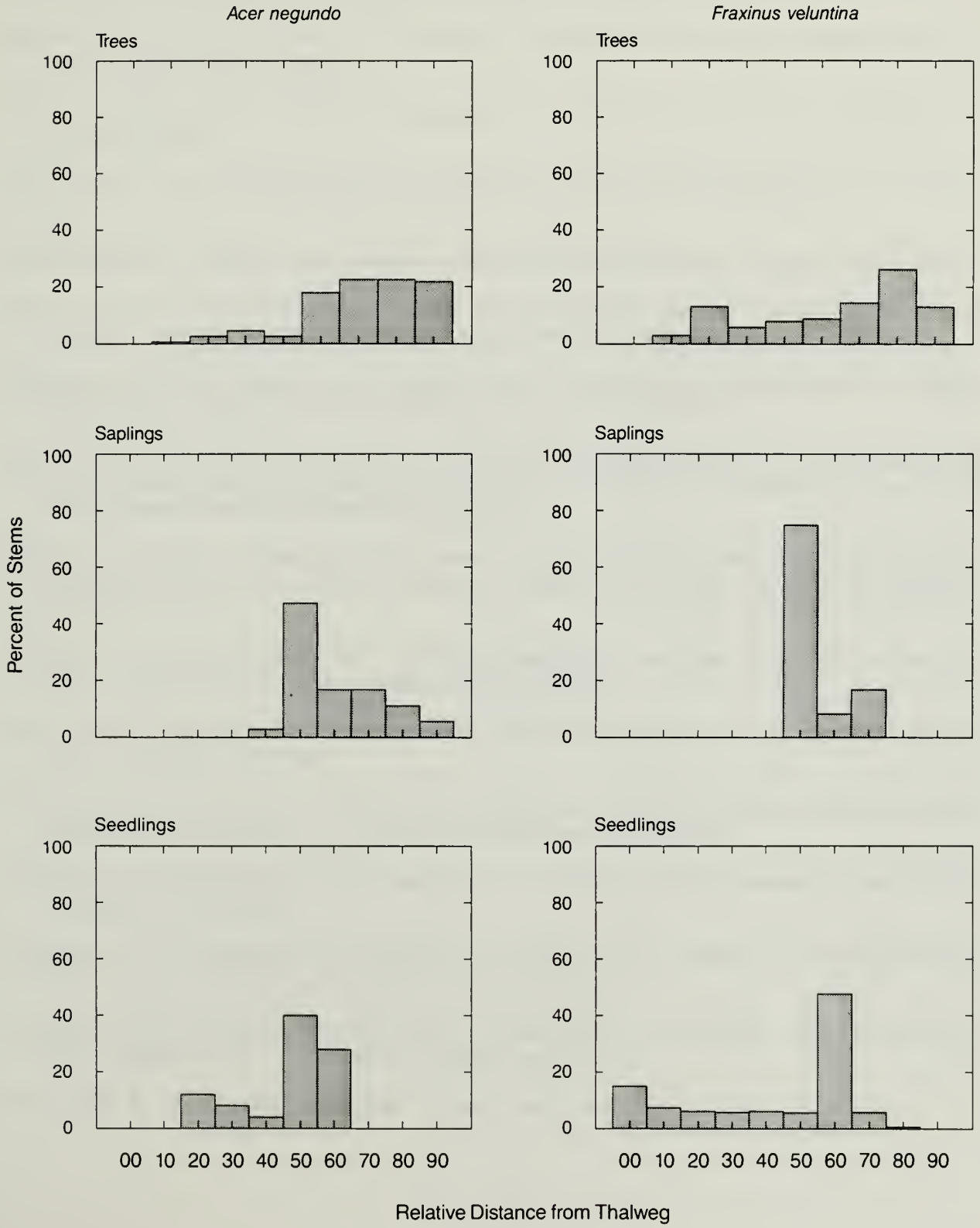


Figure 13. Histogram depicting the location of individual *Acer negundo* and *Fraxinus velutina* seedlings, saplings and adult trees for the North Fork study stream. The distance of a particular tree from the thalweg was relativized by making the data proportional to transect length.



4.0 LITERATURE CITED

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APPENDIX A

Riparian Plant Species List for Zion National Park

ZION NATIONAL PARK
RIPARIAN FLORA

PTERIDOPHYTA (Ferns and Fern Allies)

ADIANTACEAE
Adiantum capillus-veneris

EQUISETACEAE
Equisetum arvense
Equisetum laevigatum

GYMNOSPERMAE (Conifers and relatives)

CUPRESSACEAE
Juniperus osteosperma
Juniperus scopulorum

PINACEAE
Pinus monophylla

ANGIOSPERMAE (Flowering Plants)

DICOTS (Broad-leaved Plants)

ACERACEAE
Acer grandidentatum
Acer negundo

ANACARDIACEAE
Toxicodendron rydbergii

APOCYNACEAE
Apocynum cannabinum

ASTERACEAE
Achillea millefolium ssp. *lanulosa*
Anaphalis margaritacea
Artemisia nova
Artemisia campestris ssp. *scouleriana*
Artemisia dracunculus ssp. *glauca*
Artemisia filifolia
Artemisia ludoviciana
Artemisia lodoviciana ssp. *mexicana*
Aster ascendens
Aster glaucodes ssp. *pulcher*
Aster hesperius var. *laetevirens*
Baccharis emoryi
Baccharis gllutinosa

ASTERACEAE (Continued)
Brickellia californica
Brickellia longifolia
Chrysothamnus nauseosus ssp. *consimilis*
Cirsium vulgare
Cirsium wheeleri
Conyza canadensis
Erigeron divergens
Erigeron flagellaris
Erigeron sionis
Gnaphalium palustre
Gnaphalium wrightii
Gutierrezia microcephala
Haplopappus scopulorum
Heterotheca jonesii
Heterotheca villosa var. *hispida*
Hymenopappus filifolius var. *cinereus*
Lactuca serriola
Machaeranther tanacetifolia
Senecio spartioides
Solidago canadensis
Solidago sparsiflora
Sonchus asper
Sonchus oleraceus

ASTERACEAE (Continued)
Taraxacum officinale
Townsendia incana
Tragopogon dubius
Viguiera multiflora
Xanthium strumarium

BETULACEAE
Betula occidentalis

BRASSICACEAE
Dithyrea wislizenii
Nasturtium officinale

CACTACEAE
Opuntia phaeacantha var. major

CAMPANULACEAE
Lobelia cardinalis ssp. graminea

CARYOPHYLLACEAE
Stellaria calycantha var. bongardiana

CHENOPODIACEAE
Salsola iberica

CUCURBITACEAE
Cucurbita foetidissima

ELAEAGNACEAE
Elaeagnus angustifolia
Shepherdia rotundifolia

ERICACEAE
Arctostaphylos pungens

EUPHORBIACEAE
Chamaesyce glyptosperma
Chamaesyce revoluta

FABACEAE
Glycyrrhiza lepidota
Lupinus latifolius
Medicago lupulinha
Medicago sativa
Melilotus albus
Melilotus indica
Melilotus officinalis
Psoralea lanceolata
Psorothamnus fremontii
Robinia neomexicana
Trifolium repens

FAGACEAE
Quercus gambelii
Quercus turbinella

GARRYACEAE
Garrya flavescens

GENTIANACEAE
Centaurium calycosum
Centaurium exaltatum
Frasera albomarginata

GERANIACEAE
Geranium caespitosum

HYDROPHYLLACEAE
Phacelia hastata

LAMIACEAE
Mentha arvensis
Monardella odoratissima ssp. *parvifolia*
Prunella vulgaris var. *elongata*
Salvia dorrii

LINACEAE
Linum aristatum
Linum australe
Linum perenne ssp. *lewisii*

LYTHRACEAE
Lythrum californicum

MALVACEAE
Sphaeralcea grossulariifolia

NYCTAGINACEAE
Mirabilis linearis

OLEACEAE
Fraxinus anomala
Fraxinus velutina

ONAGRACEAE
Epilobium ciliatum
Epilobium halleanum
Oenothera longissima
Oenothera pallida

PLANTAGINACEAE
Plantago lanceolata
Plantago major
Plantago patagonica

POLEMONIACEAE
Eriastrum sparsiflorum
Ipomopsis congesta var. frutescens
Ipomopsis longiflora
Linanthastrum nuttallii
Linanthus bigelovii

POLYGONACEAE
Eriogonum sionis
Rumex crispus

PRIMULACEAE
Samolus valerandi ssp. parviflorus

RANUNCULACEAE
Aquilegia chrysanthya
Ranunculus cymbalaria var. saximontanus

ROSACEAE
Amelanchier utahensis
Cercocarpus intricatus
Cercocarpus ledifolius
Holodiscus dumosus
Ivesia sabulosa
Petrophytum caespitosum
Purshia tridentata
Rosa woodsii

RUBIACEAE
Galium aparine
Rubia tinctoria

SALICACEAE
Populus fremontii

SALICACEAE (Continued)
Salix exigua
Salix gooddingii
Salix lasiandra
Salix lasiolepis

SANTALACEAE
Comandra umbellata var. pallida

SCROPHULARIACEAE
Castilleja exilis
Castilleja linariifolia
Mimulus cardinalis
Mimulus floribundus
Mimulus guttatus
Penstemon palmeri var. *glandulosus*
Verbascum thapsus
Veronica americana

SOLANACEAE
Datura wrightii

TAMARICACEAE
Tamarix ramosissima

ULMACEAE
Celtis reticulata

VERBENACEAE
Verbena bracteata

VITACEAE
Vitis arizonica

MONOCOTS (Narrow-leaved Plants)

AGAVACEAE
Yucca angustissima

CYPERACEAE
Carex hystricina
Carex lanuginosa
Carex nebrascensis
Carex rostrata
Eleocharis palustris
Eleocharis parishii
Eleocharis rostulata
Hemicarpha micrantha
Scirpus acutus
Scirpus americanus
Scirpus maritimus
Scirpus microcarpus

IRIDACEAE
Sisyrinchium demissum

JUNCACEAE
Juncus balticus
Juncus bufonius
Juncus ensifolius var. *brunnescens*
Juncus ensifolius var. *montanus*
Juncus longistylis
Juncus tenuis
Juncus torreyi

LILIACEAE
Smilacina stellata

ORCHIDACEAE

Epipactis gigantea

POACEAE

Agropyron cristatum
Agropyron elongatum
Agropyron trachycaulum
Agrostis scabra
Agrostis semiverticillata
Agrostis stolonifera
Andropogon gerardii var. *chrysocoma*
Aristida longiseta
Bothriochloa barbinodis
Bouteloua barbata
Bromus carinatus
Bromus diandrus
Bromus inermis
Bromus japonica
Bromus rubens
Bromus tectorum
Clamagrostis scopulorum
Cenchrus longispinus
Dactylis glomerata
Dichanthelium acuminatum
Elymus canadensis
Elymus elynoides

POACEAE (Continued)

Festuca pratensis
Holcus lanatus
Hordeum jubatum
Muhlenbergia andina
Muhlenbergia asperifolia
Muhlenbergia montana
Muhlenbergia thurberi
Munroa squarrosa
Oryzopsis hymenoides
Panicum capillare
Phalaris arundinacea
Phleum pratense
Phragmites australis
Poa compressa
Poa glaucifolia
Poa pratensis
Polypogon monspeliensis
Schizachyrium scoparium
Sorghastrum nutans
Sporobolus contractus
Sporobolus cryptandrus
Sporobolus flexuosus

TYPHACEAE

Typha domingensis
Typha latifolia

APPENDIX B

Raw Tree Data Set

Appendix B
Raw Tree Data Set

Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code	Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code
1	EF	01	JUOC	9.0	41.0	6	56	EF	02	ELAN	17.0	427.0	6
2	EF	01	POFR	1.0	285.0	6	57	EF	02	POFR	1.0	235.0	6
3	EF	01	POFR	1.0	285.0	6	58	EF	02	POFR	2.0	456.0	6
4	EF	01	POFR	1.0	285.0	6	59	EF	02	POFR	2.0	456.0	6
5	EF	01	POFR	2.0	94.0	6	60	EF	02	POFR	2.0	452.0	6
6	EF	01	POFR	3.0	83.0	6	61	EF	02	POFR	2.0	463.0	6
7	EF	01	POFR	3.0	78.0	6	62	EF	02	POFR	3.0	756.0	6
8	EF	01	POFR	3.0	93.0	6	63	EF	02	POFR	3.0	480.0	6
9	EF	01	POFR	3.0	682.0	6	64	EF	02	POFR	3.0	470.0	6
10	EF	01	POFR	3.0	111.0	6	65	EF	02	POFR	3.0	458.0	6
11	EF	01	POFR	4.0	83.0	6	66	EF	02	POFR	3.0	480.0	6
12	EF	01	POFR	4.0	681.0	6	67	EF	02	POFR	3.0	458.0	6
13	EF	01	POFR	5.0	78.0	6	68	EF	02	POFR	3.0	458.0	6
14	EF	01	POFR	5.0	106.0	6	69	EF	02	POFR	3.0	457.0	6
15	EF	01	POFR	6.0	77.0	6	70	EF	02	POFR	3.0	756.0	6
16	EF	01	POFR	6.0	78.0	6	71	EF	02	POFR	3.0	468.0	6
17	EF	01	POFR	8.0	552.0	6	72	EF	02	POFR	3.0	453.0	6
18	EF	01	POFR	8.0	510.0	6	73	EF	02	POFR	4.0	458.0	6
19	EF	01	POFR	9.0	457.0	6	74	EF	02	POFR	4.0	542.0	6
20	EF	01	POFR	9.0	472.0	6	75	EF	02	POFR	4.0	447.0	6
21	EF	01	POFR	9.0	470.0	6	76	EF	02	POFR	4.0	460.0	6
22	EF	01	POFR	9.0	113.0	6	77	EF	02	POFR	4.0	457.0	6
23	EF	01	POFR	9.0	475.0	6	78	EF	02	POFR	4.0	652.0	6
24	EF	01	POFR	10.0	468.0	6	79	EF	02	POFR	5.0	463.0	6
25	EF	01	POFR	11.0	105.0	6	80	EF	02	POFR	5.0	671.0	6
26	EF	01	POFR	11.0	468.0	6	81	EF	02	POFR	5.0	465.0	6
27	EF	01	POFR	12.0	447.0	6	82	EF	02	POFR	7.0	456.0	6
28	EF	01	POFR	12.0	461.0	6	83	EF	02	POFR	8.0	465.0	6
29	EF	01	POFR	12.0	460.0	6	84	EF	02	POFR	8.0	560.0	6
30	EF	01	POFR	12.0	467.0	6	85	EF	02	POFR	8.0	458.0	6
31	EF	01	POFR	13.0	465.0	6	86	EF	02	POFR	8.0	456.0	6
32	EF	01	POFR	14.0	635.0	6	87	EF	02	POFR	9.0	654.0	6
33	EF	01	POFR	14.0	113.0	6	88	EF	02	POFR	10.0	458.0	6
34	EF	01	POFR	14.0	508.0	6	89	EF	02	POFR	10.0	662.0	6
35	EF	01	POFR	15.0	454.0	6	90	EF	02	POFR	10.0	780.0	6
36	EF	01	POFR	15.0	462.0	6	91	EF	02	POFR	14.0	644.0	6
37	EF	01	POFR	15.0	545.0	6	92	EF	02	POFR	15.0	675.0	6
38	EF	01	POFR	15.0	504.0	6	93	EF	02	POFR	15.0	572.0	6
39	EF	01	POFR	16.0	435.0	6	94	EF	02	POFR	16.0	570.0	6
40	EF	01	POFR	19.0	512.0	6	95	EF	02	POFR	17.0	582.0	6
41	EF	01	POFR	20.0	475.0	6	96	EF	02	POFR	18.0	207.0	3
42	EF	01	POFR	20.0	445.0	6	97	EF	02	POFR	18.0	447.0	6
43	EF	01	POFR	22.0	550.0	6	98	EF	02	POFR	19.0	575.0	6
44	EF	01	POFR	22.0	550.0	6	99	EF	02	POFR	19.0	207.0	3
45	EF	01	POFR	24.0	793.0	6	100	EF	02	POFR	21.0	640.0	6
46	EF	01	POFR	26.0	460.0	6	101	EF	02	POFR	49.0	40.0	6
47	EF	02	ELAN	5.0	427.0	6	102	EF	02	POFR	51.0	3.0	6
48	EF	02	ELAN	5.0	428.0	6	103	EF	03	FRVE	1.0	735.0	6
49	EF	02	ELAN	6.0	430.0	6	104	EF	03	FRVE	1.0	735.0	6
50	EF	02	ELAN	8.0	428.0	6	105	EF	03	FRVE	1.0	735.0	6
51	EF	02	ELAN	8.0	425.0	6	106	EF	03	FRVE	2.0	974.0	6
52	EF	02	ELAN	11.0	426.0	6	107	EF	03	JUOC	17.0	185.0	6
53	EF	02	ELAN	12.0	427.0	6	108	EF	03	POFR	1.0	735.0	6
54	EF	02	ELAN	13.0	429.0	6	109	EF	03	POFR	1.0	880.0	6
55	EF	02	ELAN	15.0	428.0	6	110	EF	03	POFR	1.0	877.0	6

Appendix B (Continued)
Raw Tree Data Set

Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code	Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code
111	EF	03	POFR	1.0	883.0	6	166	EF	04	POFR	5.0	510.0	6
112	EF	03	POFR	1.0	883.0	6	167	EF	04	POFR	5.0	500.0	6
113	EF	03	POFR	1.0	880.0	6	168	EF	04	POFR	6.0	917.0	6
114	EF	03	POFR	1.0	735.0	6	169	EF	04	POFR	6.0	906.0	6
115	EF	03	POFR	1.0	881.0	6	170	EF	04	POFR	6.0	513.0	6
116	EF	03	POFR	1.0	735.0	6	171	EF	04	POFR	6.0	512.0	6
117	EF	03	POFR	1.0	880.0	6	172	EF	04	POFR	7.0	907.0	6
118	EF	03	POFR	1.0	950.0	6	173	EF	04	POFR	7.0	515.0	6
119	EF	03	POFR	1.0	950.0	6	174	EF	04	POFR	7.0	519.0	6
120	EF	03	POFR	2.0	698.0	4	175	EF	04	POFR	7.0	513.0	6
121	EF	03	POFR	2.0	670.0	6	176	EF	04	POFR	8.0	507.0	6
122	EF	03	POFR	2.0	880.0	6	177	EF	04	POFR	9.0	513.0	6
123	EF	03	POFR	2.0	877.0	6	178	EF	04	POFR	9.0	507.0	6
124	EF	03	POFR	2.0	881.0	6	179	EF	04	POFR	10.0	506.0	6
125	EF	03	POFR	2.0	670.0	6	180	EF	04	POFR	11.0	917.0	6
126	EF	03	POFR	2.0	881.0	6	181	EF	04	POFR	11.0	527.0	6
127	EF	03	POFR	2.0	735.0	6	182	EF	04	POFR	12.0	510.0	6
128	EF	03	POFR	2.0	881.0	6	183	EF	04	POFR	13.0	506.0	6
129	EF	03	POFR	2.0	963.0	6	184	EF	04	POFR	14.0	1200.0	2
130	EF	03	POFR	3.0	883.0	6	185	EF	04	POFR	14.0	527.0	6
131	EF	03	POFR	3.0	668.0	6	186	EF	04	POFR	14.0	515.0	6
132	EF	03	POFR	5.0	650.0	6	187	EF	04	POFR	14.0	1192.0	2
133	EF	03	POFR	6.0	971.0	6	188	EF	04	POFR	14.0	1192.0	2
134	EF	03	POFR	8.0	685.0	6	189	EF	04	POFR	15.0	513.0	6
135	EF	03	POFR	10.0	983.0	6	190	EF	04	POFR	19.0	1192.0	2
136	EF	03	POFR	13.0	976.0	6	191	EF	04	POFR	20.0	506.0	6
137	EF	03	POFR	14.0	975.0	6	192	EF	04	POFR	20.0	524.0	6
138	EF	03	POFR	14.0	684.0	6	193	EF	04	POFR	21.0	500.0	6
139	EF	03	POFR	18.0	659.0	6	194	EF	05	JUOC	12.0	938.0	6
140	EF	03	POFR	22.0	649.0	6	195	EF	05	JUOC	14.0	938.0	6
141	EF	03	POFR	25.0	657.0	6	196	EF	05	POFR	2.0	883.0	6
142	EF	03	POFR	26.0	652.0	6	197	EF	05	POFR	2.0	607.0	6
143	EF	03	POFR	38.0	680.0	6	198	EF	05	POFR	2.0	610.0	6
144	EF	03	POFR	46.0	1043.0	6	199	EF	05	POFR	2.0	887.0	6
145	EF	04	JUOC	12.0	1200.0	2	200	EF	05	POFR	2.0	610.0	6
146	EF	04	JUOC	20.0	1275.0	2	201	EF	05	POFR	2.0	882.0	6
147	EF	04	POFR	2.0	905.0	6	202	EF	05	POFR	2.0	610.0	6
148	EF	04	POFR	2.0	906.0	6	203	EF	05	POFR	3.0	606.0	6
149	EF	04	POFR	2.0	503.0	6	204	EF	05	POFR	3.0	608.0	6
150	EF	04	POFR	2.0	507.0	6	205	EF	05	POFR	3.0	915.0	6
151	EF	04	POFR	2.0	905.0	6	206	EF	05	POFR	3.0	605.0	6
152	EF	04	POFR	2.0	905.0	6	207	EF	05	POFR	3.0	883.0	6
153	EF	04	POFR	2.0	905.0	6	208	EF	05	POFR	3.0	889.0	6
154	EF	04	POFR	2.0	906.0	6	209	EF	05	POFR	3.0	205.0	6
155	EF	04	POFR	2.0	912.0	6	210	EF	05	POFR	3.0	908.0	6
156	EF	04	POFR	3.0	912.0	6	211	EF	05	POFR	3.0	605.0	6
157	EF	04	POFR	3.0	906.0	6	212	EF	05	POFR	4.0	890.0	6
158	EF	04	POFR	3.0	907.0	6	213	EF	05	POFR	4.0	607.0	6
159	EF	04	POFR	4.0	494.0	6	214	EF	05	POFR	4.0	608.0	6
160	EF	04	POFR	4.0	1192.0	2	215	EF	05	POFR	5.0	608.0	6
161	EF	04	POFR	4.0	908.0	6	216	EF	05	POFR	5.0	612.0	6
162	EF	04	POFR	4.0	910.0	6	217	EF	05	POFR	5.0	899.0	6
163	EF	04	POFR	4.0	905.0	6	218	EF	05	POFR	7.0	897.0	6
164	EF	04	POFR	4.0	520.0	6	219	EF	05	POFR	7.0	614.0	6
165	EF	04	POFR	5.0	907.0	6	220	EF	05	POFR	7.0	610.0	6

Appendix B (Continued)
Raw Tree Data Set

Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code	Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code
221	EF	05	POFR	8.0	1250.0	6	276	EF	06	POFR	19.0	514.0	6
222	EF	05	POFR	8.0	1248.0	6	277	EF	06	POFR	26.0	601.0	6
223	EF	05	POFR	9.0	1242.0	6	278	EF	06	POFR	27.0	514.0	6
224	EF	05	POFR	10.0	1252.0	6	279	EF	06	POFR	44.0	12.0	4
225	EF	05	POFR	10.0	901.0	6	280	EF	07	FRAN	10.0	845.0	6
226	EF	05	POFR	11.0	610.0	6	281	EF	07	FRAN	15.0	945.0	6
227	EF	05	POFR	12.0	1250.0	6	282	EF	07	JUOC	3.0	591.0	6
228	EF	05	POFR	12.0	914.0	6	283	EF	07	JUOC	11.0	100.0	3
229	EF	05	POFR	13.0	900.0	6	284	EF	07	JUOC	12.0	120.0	3
230	EF	05	POFR	13.0	909.0	6	285	EF	07	JUOC	13.0	120.0	3
231	EF	05	POFR	14.0	1250.0	6	286	EF	07	POFR	1.0	461.0	6
232	EF	05	POFR	14.0	925.0	6	287	EF	07	POFR	1.0	375.0	4
233	EF	05	POFR	15.0	1235.0	6	288	EF	07	POFR	1.0	461.0	6
234	EF	05	POFR	15.0	909.0	6	289	EF	07	POFR	1.0	461.0	6
235	EF	05	POFR	15.0	882.0	6	290	EF	07	POFR	2.0	613.0	6
236	EF	05	POFR	17.0	914.0	6	291	EF	07	POFR	2.0	614.0	6
237	EF	05	POFR	18.0	925.0	6	292	EF	07	POFR	2.0	621.0	6
238	EF	05	POFR	20.0	909.0	6	293	EF	07	POFR	2.0	605.0	6
239	EF	05	POFR	24.0	1245.0	6	294	EF	07	POFR	3.0	614.0	6
240	EF	05	POFR	28.0	1240.0	6	295	EF	07	POFR	4.0	619.0	6
241	EF	05	POFR	31.0	611.0	6	296	EF	07	POFR	5.0	633.0	6
242	EF	05	POFR	39.0	605.0	6	297	EF	07	POFR	6.0	615.0	6
243	EF	06	POFR	1.0	398.0	4	298	EF	07	POFR	6.0	617.0	6
244	EF	06	POFR	1.0	488.0	4	299	EF	07	POFR	6.0	620.0	6
245	EF	06	POFR	1.0	410.0	4	300	EF	07	POFR	8.0	621.0	6
246	EF	06	POFR	1.0	420.0	2	301	EF	07	POFR	9.0	613.0	6
247	EF	06	POFR	2.0	506.0	6	302	EF	07	POFR	9.0	611.0	6
248	EF	06	POFR	2.0	497.0	4	303	EF	07	POFR	10.0	615.0	6
249	EF	06	POFR	2.0	512.0	6	304	EF	07	POFR	18.0	617.0	6
250	EF	06	POFR	2.0	524.0	6	305	EF	07	POFR	19.0	614.0	6
251	EF	06	POFR	2.0	205.0	4	306	EF	07	POFR	21.0	616.0	6
252	EF	06	POFR	2.0	526.0	6	307	EF	07	POFR	22.0	620.0	6
253	EF	06	POFR	2.0	512.0	6	308	EF	07	POFR	33.0	622.0	6
254	EF	06	POFR	2.0	506.0	6	309	NF	01	ACNE	1.0	1083.0	6
255	EF	06	POFR	3.0	510.0	6	310	NF	01	ACNE	1.0	1083.0	6
256	EF	06	POFR	3.0	488.0	4	311	NF	01	ACNE	1.0	1023.0	6
257	EF	06	POFR	3.0	496.0	6	312	NF	01	ACNE	1.0	1083.0	6
258	EF	06	POFR	3.0	508.0	6	313	NF	01	ACNE	1.0	1083.0	6
259	EF	06	POFR	4.0	610.0	6	314	NF	01	ACNE	1.0	1058.0	6
260	EF	06	POFR	4.0	535.0	6	315	NF	01	ACNE	1.0	1084.0	6
261	EF	06	POFR	4.0	593.0	6	316	NF	01	ACNE	1.0	1084.0	6
262	EF	06	POFR	4.0	496.0	6	317	NF	01	ACNE	1.0	1006.0	6
263	EF	06	POFR	5.0	530.0	6	318	NF	01	ACNE	11.0	526.0	6
264	EF	06	POFR	5.0	519.0	6	319	NF	01	ACNE	11.0	306.0	6
265	EF	06	POFR	6.0	524.0	6	320	NF	01	ACNE	19.0	1185.0	2
266	EF	06	POFR	6.0	530.0	6	321	NF	01	ACNE	21.0	1142.0	6
267	EF	06	POFR	6.0	610.0	6	322	NF	01	BEOC	1.0	1080.0	6
268	EF	06	POFR	6.0	523.0	6	323	NF	01	FRAN	1.0	1037.0	6
269	EF	06	POFR	7.0	530.0	6	324	NF	01	FRAN	1.0	1019.0	6
270	EF	06	POFR	7.0	610.0	6	325	NF	01	FRAN	1.0	1038.0	6
271	EF	06	POFR	8.0	599.0	6	326	NF	01	FRAN	1.0	1054.0	6
272	EF	06	POFR	10.0	230.0	6	327	NF	01	FRAN	1.0	1003.0	6
273	EF	06	POFR	11.0	536.0	6	328	NF	01	FRAN	1.0	1058.0	6
274	EF	06	POFR	12.0	620.0	6	329	NF	01	FRAN	1.0	1037.0	6
275	EF	06	POFR	17.0	518.0	6	330	NF	01	FRAN	1.0	1005.0	6

Appendix B (Continued)
Raw Tree Data Set

Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code	Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code
331	NF	01	FRAN	1.0	1038.0	6	386	NF	02	ACNE	1.0	791.0	6
332	NF	01	FRAN	1.0	1021.0	6	387	NF	02	ACNE	8.0	1140.0	6
333	NF	01	FRAN	1.0	1005.0	6	388	NF	02	ACNE	13.0	1130.0	6
334	NF	01	FRAN	1.0	1019.0	6	389	NF	02	ACNE	18.0	1150.0	6
335	NF	01	FRAN	1.0	1037.0	6	390	NF	02	BEOC	1.0	823.0	6
336	NF	01	FRAN	1.0	1002.0	6	391	NF	02	BEOC	1.0	823.0	6
337	NF	01	FRVE	34.0	1150.0	6	392	NF	02	FRAN	1.0	316.0	6
338	NF	01	POFR	1.0	880.0	4	393	NF	02	FRAN	1.0	802.0	6
339	NF	01	POFR	1.0	686.0	6	394	NF	02	FRAN	1.0	719.0	6
340	NF	01	POFR	1.0	880.0	4	395	NF	02	FRAN	1.0	320.0	6
341	NF	01	POFR	1.0	880.0	4	396	NF	02	FRAN	1.0	316.0	6
342	NF	01	POFR	1.0	1000.0	6	397	NF	02	FRAN	1.0	361.0	6
343	NF	01	POFR	1.0	880.0	4	398	NF	02	FRAN	1.0	445.0	6
344	NF	01	POFR	1.0	632.0	6	399	NF	02	FRAN	1.0	814.0	6
345	NF	01	POFR	1.0	870.0	6	400	NF	02	FRAN	1.0	321.0	6
346	NF	01	POFR	1.0	1046.0	6	401	NF	02	FRAN	1.0	315.0	6
347	NF	01	POFR	1.0	1047.0	6	402	NF	02	FRAN	1.0	844.0	6
348	NF	01	POFR	1.0	1032.0	6	403	NF	02	FRAN	1.0	833.0	6
349	NF	01	POFR	1.0	865.0	6	404	NF	02	FRAN	1.0	323.0	6
350	NF	01	POFR	1.0	751.0	6	405	NF	02	FRAN	1.0	833.0	6
351	NF	01	POFR	1.0	1058.0	6	406	NF	02	FRAN	1.0	317.0	6
352	NF	01	POFR	1.0	1007.0	6	407	NF	02	FRAN	1.0	801.0	6
353	NF	01	POFR	1.0	684.0	6	408	NF	02	FRAN	1.0	795.0	6
354	NF	01	POFR	1.0	880.0	4	409	NF	02	FRAN	1.0	772.0	6
355	NF	01	POFR	1.0	859.0	6	410	NF	02	FRAN	1.0	315.0	6
356	NF	01	POFR	1.0	1003.0	6	411	NF	02	FRAN	1.0	312.0	6
357	NF	01	POFR	1.0	880.0	4	412	NF	02	FRAN	1.0	320.0	6
358	NF	01	POFR	1.0	1044.0	6	413	NF	02	FRAN	1.0	445.0	6
359	NF	01	POFR	1.0	746.0	6	414	NF	02	FRAN	1.0	346.0	6
360	NF	01	POFR	1.0	675.0	6	415	NF	02	FRAN	1.0	325.0	6
361	NF	01	POFR	1.0	661.0	6	416	NF	02	FRAN	1.0	315.0	6
362	NF	01	POFR	1.0	1058.0	6	417	NF	02	FRAN	1.0	312.0	6
363	NF	01	POFR	1.0	721.0	6	418	NF	02	FRAN	1.0	316.0	6
364	NF	01	POFR	1.0	1002.0	6	419	NF	02	FRAN	1.0	316.0	6
365	NF	01	POFR	1.0	1032.0	6	420	NF	02	FRAN	1.0	312.0	6
366	NF	01	POFR	1.0	1000.0	6	421	NF	02	FRAN	1.0	860.0	6
367	NF	01	POFR	2.0	723.0	6	422	NF	02	FRAN	1.0	328.0	6
368	NF	01	POFR	2.0	621.0	6	423	NF	02	FRAN	1.0	801.0	6
369	NF	01	POFR	2.0	726.0	6	424	NF	02	FRAN	1.0	321.0	6
370	NF	01	POFR	2.0	733.0	6	425	NF	02	FRAN	1.0	317.0	6
371	NF	01	POFR	2.0	738.0	6	426	NF	02	FRAN	1.0	814.0	6
372	NF	01	POFR	2.0	728.0	6	427	NF	02	FRAN	1.0	328.0	6
373	NF	01	POFR	2.0	693.0	6	428	NF	02	FRAN	1.0	443.0	6
374	NF	01	POFR	2.0	687.0	6	429	NF	02	FRAN	1.0	719.0	6
375	NF	01	POFR	2.0	650.0	6	430	NF	02	FRAN	1.0	880.0	6
376	NF	01	POFR	2.0	650.0	6	431	NF	02	FRAN	1.0	326.0	6
377	NF	01	POFR	2.0	834.0	6	432	NF	02	FRAN	1.0	841.0	6
378	NF	01	POFR	3.0	693.0	6	433	NF	02	FRAN	1.0	856.0	6
379	NF	01	POFR	3.0	880.0	4	434	NF	02	FRAN	1.0	841.0	6
380	NF	01	POFR	18.0	41.0	3	435	NF	02	FRAN	1.0	326.0	6
381	NF	01	POFR	22.0	34.0	3	436	NF	02	FRAN	1.0	831.0	6
382	NF	01	POFR	28.0	40.0	3	437	NF	02	FRAN	1.0	312.0	6
383	NF	01	POFR	28.0	39.0	3	438	NF	02	FRAN	1.0	719.0	6
384	NF	01	POFR	31.0	30.0	3	439	NF	02	FRAN	1.0	316.0	6
385	NF	01	TARA	13.0	218.0	6	440	NF	02	FRAN	1.0	719.0	6

Appendix B (Continued)
Raw Tree Data Set

Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code	Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code
441	NF	02	FRAN	1.0	345.0	6	496	NF	02	POFR	2.0	436.0	6
442	NF	02	FRAN	21.0	22.0	6	497	NF	02	POFR	2.0	557.0	6
443	NF	02	FRAN	24.0	8.0	6	498	NF	02	POFR	2.0	438.0	6
444	NF	02	FRAN	41.0	10.0	6	499	NF	02	POFR	2.0	394.0	6
445	NF	02	FRVE	19.0	1155.0	6	500	NF	02	POFR	2.0	376.0	6
446	NF	02	POFR	1.0	770.0	6	501	NF	02	POFR	2.0	369.0	6
447	NF	02	POFR	1.0	548.0	6	502	NF	02	POFR	2.0	372.0	6
448	NF	02	POFR	1.0	540.0	6	503	NF	02	POFR	2.0	368.0	6
449	NF	02	POFR	1.0	315.0	6	504	NF	02	POFR	2.0	394.0	6
450	NF	02	POFR	1.0	330.0	6	505	NF	02	POFR	2.0	521.0	6
451	NF	02	POFR	1.0	836.0	6	506	NF	02	POFR	2.0	542.0	6
452	NF	02	POFR	1.0	495.0	6	507	NF	02	POFR	3.0	548.0	6
453	NF	02	POFR	1.0	328.0	6	508	NF	02	POFR	28.0	27.0	6
454	NF	02	POFR	1.0	521.0	6	509	NF	02	POFR	31.0	40.0	6
455	NF	02	POFR	1.0	429.0	6	510	NF	02	POFR	47.0	95.0	6
456	NF	02	POFR	1.0	435.0	6	511	NF	02	TARA	4.0	418.0	6
457	NF	02	POFR	1.0	837.0	6	512	NF	02	TARA	5.0	377.0	6
458	NF	02	POFR	1.0	522.0	6	513	NF	02	TARA	6.0	914.0	6
459	NF	02	POFR	1.0	537.0	6	514	NF	02	TARA	7.0	1080.0	6
460	NF	02	POFR	1.0	544.0	6	515	NF	02	TARA	7.0	1077.0	6
461	NF	02	POFR	1.0	830.0	6	516	NF	02	TARA	8.0	1020.0	6
462	NF	02	POFR	1.0	602.0	6	517	NF	02	TARA	10.0	1140.0	6
463	NF	02	POFR	1.0	601.0	6	518	NF	02	TARA	11.0	1050.0	6
464	NF	02	POFR	1.0	770.0	6	519	NF	02	TARA	14.0	1020.0	6
465	NF	02	POFR	1.0	801.0	6	520	NF	02	TARA	27.0	1108.0	6
466	NF	02	POFR	1.0	342.0	6	521	NF	02	TARA	80.0	1080.0	6
467	NF	02	POFR	1.0	322.0	6	522	NF	03	ACNE	1.0	615.0	4
468	NF	02	POFR	1.0	783.0	6	523	NF	03	ACNE	1.0	472.0	6
469	NF	02	POFR	1.0	421.0	6	524	NF	03	ACNE	4.0	705.0	6
470	NF	02	POFR	1.0	598.0	6	525	NF	03	ACNE	4.0	705.0	6
471	NF	02	POFR	1.0	779.0	6	526	NF	03	ACNE	5.0	705.0	6
472	NF	02	POFR	1.0	364.0	6	527	NF	03	ACNE	7.0	80.0	6
473	NF	02	POFR	1.0	521.0	6	528	NF	03	ACNE	9.0	80.0	6
474	NF	02	POFR	1.0	436.0	6	529	NF	03	ACNE	11.0	75.0	6
475	NF	02	POFR	1.0	585.0	6	530	NF	03	ACNE	15.0	980.0	2
476	NF	02	POFR	1.0	538.0	6	531	NF	03	ACNE	17.0	973.0	3
477	NF	02	POFR	1.0	464.0	6	532	NF	03	ACNE	18.0	970.0	3
478	NF	02	POFR	1.0	527.0	6	533	NF	03	ACNE	19.0	80.0	6
479	NF	02	POFR	1.0	394.0	6	534	NF	03	ACNE	19.0	885.0	6
480	NF	02	POFR	1.0	367.0	6	535	NF	03	FRVE	1.0	527.0	4
481	NF	02	POFR	1.0	324.0	6	536	NF	03	FRVE	1.0	547.0	4
482	NF	02	POFR	1.0	437.0	6	537	NF	03	FRVE	1.0	521.0	4
483	NF	02	POFR	1.0	596.0	6	538	NF	03	FRVE	3.0	688.0	6
484	NF	02	POFR	1.0	529.0	6	539	NF	03	FRVE	18.0	50.0	6
485	NF	02	POFR	1.0	565.0	6	540	NF	03	FRVE	23.0	85.0	6
486	NF	02	POFR	1.0	426.0	6	541	NF	03	FRVE	26.0	50.0	6
487	NF	02	POFR	2.0	539.0	6	542	NF	03	FRVE	30.0	50.0	6
488	NF	02	POFR	2.0	382.0	6	543	NF	03	FRVE	31.0	85.0	6
489	NF	02	POFR	2.0	590.0	6	544	NF	03	FRVE	40.0	985.0	2
490	NF	02	POFR	2.0	373.0	6	545	NF	03	POFR	1.0	509.0	6
491	NF	02	POFR	2.0	585.0	6	546	NF	03	POFR	1.0	564.0	6
492	NF	02	POFR	2.0	438.0	6	547	NF	03	POFR	1.0	268.0	6
493	NF	02	POFR	2.0	427.0	6	548	NF	03	POFR	1.0	542.0	6
494	NF	02	POFR	2.0	544.0	6	549	NF	03	POFR	1.0	486.0	6
495	NF	02	POFR	2.0	564.0	6	550	NF	03	POFR	5.0	706.0	6

Appendix B (Continued)
Raw Tree Data Set

Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code	Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code
551	NF	03	POFR	6.0	715.0	6	606	NF	04	FRVE	1.0	85.0	6
552	NF	03	POFR	7.0	703.0	6	607	NF	04	FRVE	1.0	157.0	6
553	NF	03	POFR	9.0	700.0	6	608	NF	04	FRVE	1.0	479.0	4
554	NF	03	POFR	9.0	704.0	6	609	NF	04	FRVE	1.0	479.0	4
555	NF	03	POFR	37.0	970.0	6	610	NF	04	FRVE	1.0	197.0	6
556	NF	03	POFR	53.0	975.0	3	611	NF	04	FRVE	1.0	134.0	6
557	NF	03	QUTU	7.0	40.0	2	612	NF	04	FRVE	1.0	128.0	6
558	NF	03	TARA	6.0	740.0	6	613	NF	04	FRVE	1.0	677.0	6
559	NF	04	ACNE	1.0	486.0	4	614	NF	04	FRVE	1.0	478.0	4
560	NF	04	ACNE	7.0	970.0	6	615	NF	04	FRVE	1.0	129.0	6
561	NF	04	ACNE	8.0	1030.0	3	616	NF	04	FRVE	1.0	479.0	4
562	NF	04	ACNE	11.0	1030.0	3	617	NF	04	FRVE	1.0	479.0	4
563	NF	04	ACNE	18.0	968.0	6	618	NF	04	FRVE	1.0	86.0	6
564	NF	04	ACNE	24.0	970.0	6	619	NF	04	FRVE	1.0	103.0	6
565	NF	04	FRVE	1.0	478.0	4	620	NF	04	FRVE	1.0	78.0	6
566	NF	04	FRVE	1.0	478.0	4	621	NF	04	FRVE	1.0	90.0	6
567	NF	04	FRVE	1.0	175.0	6	622	NF	04	FRVE	1.0	226.0	6
568	NF	04	FRVE	1.0	478.0	4	623	NF	04	FRVE	22.0	20.0	6
569	NF	04	FRVE	1.0	123.0	6	624	NF	04	POFR	1.0	543.0	6
570	NF	04	FRVE	1.0	479.0	4	625	NF	04	POFR	1.0	729.0	4
571	NF	04	FRVE	1.0	187.0	6	626	NF	04	POFR	4.0	140.0	6
572	NF	04	FRVE	1.0	132.0	6	627	NF	04	POFR	9.0	37.0	2
573	NF	04	FRVE	1.0	478.0	4	628	NF	04	POFR	24.0	35.0	3
574	NF	04	FRVE	1.0	479.0	4	629	NF	04	POFR	29.0	35.0	3
575	NF	04	FRVE	1.0	627.0	6	630	NF	04	POFR	31.0	20.0	6
576	NF	04	FRVE	1.0	683.0	6	631	NF	04	POFR	37.0	957.0	6
577	NF	04	FRVE	1.0	627.0	6	632	NF	04	TARA	8.0	220.0	6
578	NF	04	FRVE	1.0	479.0	4	633	NF	04	TARA	9.0	220.0	6
579	NF	04	FRVE	1.0	479.0	4	634	NF	05	ACNE	4.0	689.0	6
580	NF	04	FRVE	1.0	130.0	6	635	NF	05	ACNE	5.0	1067.0	3
581	NF	04	FRVE	1.0	124.0	6	636	NF	05	ACNE	6.0	123.0	6
582	NF	04	FRVE	1.0	77.0	6	637	NF	05	ACNE	7.0	886.0	6
583	NF	04	FRVE	1.0	110.0	6	638	NF	05	ACNE	9.0	940.0	6
584	NF	04	FRVE	1.0	126.0	6	639	NF	05	ACNE	11.0	1075.0	3
585	NF	04	FRVE	1.0	97.0	6	640	NF	05	ACNE	11.0	1075.0	3
586	NF	04	FRVE	1.0	87.0	6	641	NF	05	ACNE	11.0	880.0	6
587	NF	04	FRVE	1.0	84.0	6	642	NF	05	ACNE	12.0	950.0	6
588	NF	04	FRVE	1.0	73.0	6	643	NF	05	ACNE	12.0	1060.0	3
589	NF	04	FRVE	1.0	116.0	6	644	NF	05	ACNE	15.0	920.0	6
590	NF	04	FRVE	1.0	97.0	6	645	NF	05	ACNE	15.0	126.0	6
591	NF	04	FRVE	1.0	88.0	6	646	NF	05	ACNE	16.0	120.0	6
592	NF	04	FRVE	1.0	480.0	4	647	NF	05	ACNE	16.0	730.0	6
593	NF	04	FRVE	1.0	74.0	6	648	NF	05	ACNE	16.0	1080.0	3
594	NF	04	FRVE	1.0	91.0	6	649	NF	05	ACNE	16.0	139.0	6
595	NF	04	FRVE	1.0	479.0	4	650	NF	05	ACNE	18.0	730.0	6
596	NF	04	FRVE	1.0	478.0	4	651	NF	05	ACNE	22.0	128.0	6
597	NF	04	FRVE	1.0	478.0	4	652	NF	05	ACNE	22.0	940.0	6
598	NF	04	FRVE	1.0	479.0	4	653	NF	05	ACNE	23.0	130.0	6
599	NF	04	FRVE	1.0	90.0	6	654	NF	05	ACNE	23.0	130.0	6
600	NF	04	FRVE	1.0	122.0	6	655	NF	05	FRVE	1.0	589.0	4
601	NF	04	FRVE	1.0	742.0	4	656	NF	05	FRVE	22.0	896.0	6
602	NF	04	FRVE	1.0	627.0	6	657	NF	05	POFR	1.0	560.0	6
603	NF	04	FRVE	1.0	86.0	6	658	NF	05	SAGO	26.0	136.0	6
604	NF	04	FRVE	1.0	478.0	4	659	NF	06	ACNE	1.0	447.0	4
605	NF	04	FRVE	1.0	706.0	6	660	NF	06	ACNE	1.0	333.0	6

Appendix B (Continued)
Raw Tree Data Set

Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code	Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code
661	NF	06	ACNE	8.0	980.0	6	716	NF	06	QUTU	4.0	44.0	2
662	NF	06	ACNE	11.0	836.0	6	717	NF	06	QUTU	9.0	56.0	2
663	NF	06	ACNE	12.0	874.0	6	718	NF	07	ACNE	6.0	1244.0	2
664	NF	06	ACNE	15.0	5.0	6	719	NF	07	ACNE	9.0	1244.0	2
665	NF	06	ACNE	16.0	850.0	6	720	NF	07	ACNE	10.0	185.0	6
666	NF	06	ACNE	16.0	910.0	6	721	NF	07	ACNE	11.0	1244.0	2
667	NF	06	ACNE	21.0	980.0	6	722	NF	07	ACNE	12.0	85.0	6
668	NF	06	ACNE	21.0	980.0	6	723	NF	07	ACNE	13.0	85.0	6
669	NF	06	FRVE	1.0	533.0	4	724	NF	07	ACNE	13.0	85.0	6
670	NF	06	FRVE	1.0	323.0	4	725	NF	07	ACNE	13.0	1200.0	2
671	NF	06	FRVE	1.0	484.0	6	726	NF	07	ACNE	14.0	1200.0	2
672	NF	06	FRVE	1.0	132.0	6	727	NF	07	ACNE	16.0	90.0	6
673	NF	06	FRVE	1.0	505.0	6	728	NF	07	ACNE	18.0	185.0	6
674	NF	06	FRVE	1.0	132.0	6	729	NF	07	ACNE	18.0	79.0	2
675	NF	06	FRVE	1.0	544.0	4	730	NF	07	ACNE	19.0	85.0	6
676	NF	06	FRVE	1.0	576.0	4	731	NF	07	ACNE	19.0	280.0	6
677	NF	06	FRVE	1.0	155.0	4	732	NF	07	ACNE	20.0	1200.0	2
678	NF	06	FRVE	1.0	566.0	4	733	NF	07	ACNE	21.0	1225.0	2
679	NF	06	FRVE	1.0	551.0	4	734	NF	07	ACNE	21.0	106.0	6
680	NF	06	FRVE	1.0	539.0	4	735	NF	07	ACNE	21.0	365.0	6
681	NF	06	FRVE	1.0	446.0	6	736	NF	07	ACNE	23.0	87.0	6
682	NF	06	FRVE	1.0	561.0	4	737	NF	07	ACNE	26.0	185.0	6
683	NF	06	FRVE	1.0	571.0	4	738	NF	07	CERE	4.0	50.0	2
684	NF	06	FRVE	1.0	568.0	4	739	NF	07	CERE	7.0	50.0	2
685	NF	06	FRVE	1.0	489.0	6	740	NF	07	CERE	7.0	44.0	2
686	NF	06	FRVE	1.0	562.0	4	741	NF	07	CERE	10.0	27.0	2
687	NF	06	FRVE	1.0	150.0	4	742	NF	07	FRVE	1.0	1005.0	6
688	NF	06	FRVE	1.0	132.0	6	743	NF	07	FRVE	1.0	1005.0	6
689	NF	06	FRVE	1.0	312.0	4	744	NF	07	FRVE	1.0	1005.0	6
690	NF	06	FRVE	1.0	94.0	4	745	NF	07	FRVE	1.0	1000.0	6
691	NF	06	FRVE	1.0	446.0	4	746	NF	07	FRVE	1.0	1085.0	6
692	NF	06	FRVE	1.0	571.0	4	747	NF	07	FRVE	1.0	1000.0	6
693	NF	06	FRVE	1.0	539.0	4	748	NF	07	FRVE	1.0	1005.0	6
694	NF	06	FRVE	1.0	556.0	4	749	NF	07	FRVE	1.0	1005.0	6
695	NF	06	FRVE	1.0	420.0	6	750	NF	07	FRVE	1.0	1077.0	6
696	NF	06	FRVE	1.0	132.0	6	751	NF	07	FRVE	1.0	1077.0	6
697	NF	06	FRVE	1.0	150.0	4	752	NF	07	FRVE	1.0	1085.0	6
698	NF	06	FRVE	6.0	71.0	6	753	NF	07	FRVE	1.0	1005.0	6
699	NF	06	FRVE	7.0	71.0	6	754	NF	07	FRVE	1.0	1005.0	6
700	NF	06	FRVE	8.0	717.0	4	755	NF	07	FRVE	1.0	1005.0	6
701	NF	06	FRVE	10.0	75.0	6	756	NF	07	FRVE	1.0	1085.0	6
702	NF	06	FRVE	11.0	75.0	6	757	NF	07	FRVE	1.0	1085.0	6
703	NF	06	FRVE	12.0	820.0	6	758	NF	07	FRVE	1.0	1005.0	6
704	NF	06	FRVE	14.0	822.0	6	759	NF	07	FRVE	1.0	1174.0	4
705	NF	06	FRVE	16.0	71.0	6	760	NF	07	FRVE	1.0	1085.0	6
706	NF	06	FRVE	18.0	791.0	6	761	NF	07	FRVE	1.0	1085.0	6
707	NF	06	FRVE	38.0	1000.0	2	762	NF	07	FRVE	1.0	1005.0	6
708	NF	06	POFR	1.0	343.0	6	763	NF	07	FRVE	1.0	1085.0	6
709	NF	06	POFR	1.0	343.0	6	764	NF	07	FRVE	1.0	1005.0	6
710	NF	06	POFR	1.0	324.0	4	765	NF	07	FRVE	15.0	300.0	6
711	NF	06	POFR	1.0	322.0	4	766	NF	07	FRVE	18.0	152.0	6
712	NF	06	POFR	1.0	326.0	4	767	NF	07	FRVE	20.0	160.0	6
713	NF	06	POFR	1.0	352.0	6	768	NF	07	FRVE	26.0	355.0	6
714	NF	06	QUTU	2.0	44.0	2	769	NF	07	FRVE	28.0	267.0	6
715	NF	06	QUTU	2.0	721.0	4	770	NF	07	POFR	1.0	887.0	6

Appendix B (Continued)
Raw Tree Data Set

Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code	Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code
771	NF	07	POFR	36.0	1213.0	2	826	NF	08	FRVE	1.0	1568.0	6
772	NF	07	POFR	78.0	510.0	6	827	NF	08	FRVE	1.0	1522.0	6
773	NF	07	POFR	83.0	655.0	6	828	NF	08	FRVE	1.0	1502.0	6
774	NF	07	POFR	90.0	295.0	6	829	NF	08	FRVE	1.0	1500.0	6
775	NF	07	QUTU	11.0	24.0	6	830	NF	08	FRVE	1.0	1502.0	6
776	NF	08	ACNE	2.0	506.0	6	831	NF	08	FRVE	1.0	1507.0	6
777	NF	08	ACNE	2.0	383.0	6	832	NF	08	FRVE	1.0	1506.0	6
778	NF	08	ACNE	3.0	163.0	6	833	NF	08	FRVE	1.0	1522.0	6
779	NF	08	ACNE	3.0	161.0	6	834	NF	08	FRVE	1.0	1501.0	6
780	NF	08	ACNE	4.0	468.0	6	835	NF	08	FRVE	1.0	1500.0	6
781	NF	08	ACNE	4.0	198.0	6	836	NF	08	FRVE	1.0	1523.0	6
782	NF	08	ACNE	5.0	468.0	6	837	NF	08	FRVE	1.0	1506.0	6
783	NF	08	ACNE	6.0	427.0	6	838	NF	08	FRVE	1.0	1566.0	6
784	NF	08	ACNE	6.0	310.0	6	839	NF	08	FRVE	1.0	1508.0	6
785	NF	08	ACNE	6.0	279.0	6	840	NF	08	FRVE	1.0	1519.0	6
786	NF	08	ACNE	7.0	551.0	6	841	NF	08	FRVE	1.0	1516.0	6
787	NF	08	ACNE	7.0	387.0	6	842	NF	08	FRVE	1.0	1519.0	6
788	NF	08	ACNE	7.0	376.0	6	843	NF	08	FRVE	1.0	1507.0	6
789	NF	08	ACNE	7.0	497.0	6	844	NF	08	FRVE	1.0	1500.0	6
790	NF	08	ACNE	7.0	503.0	6	845	NF	08	FRVE	1.0	1566.0	6
791	NF	08	ACNE	8.0	198.0	6	846	NF	08	FRVE	1.0	1501.0	6
792	NF	08	ACNE	8.0	507.0	6	847	NF	08	FRVE	1.0	1502.0	6
793	NF	08	ACNE	8.0	410.0	6	848	NF	08	FRVE	1.0	1518.0	6
794	NF	08	ACNE	9.0	271.0	6	849	NF	08	FRVE	1.0	1492.0	6
795	NF	08	ACNE	9.0	279.0	6	850	NF	08	FRVE	1.0	1519.0	6
796	NF	08	ACNE	9.0	541.0	6	851	NF	08	FRVE	1.0	1566.0	6
797	NF	08	ACNE	9.0	100.0	6	852	NF	08	FRVE	1.0	1520.0	6
798	NF	08	ACNE	9.0	521.0	6	853	NF	08	FRVE	6.0	152.0	6
799	NF	08	ACNE	9.0	262.0	6	854	NF	08	FRVE	9.0	135.0	6
800	NF	08	ACNE	10.0	469.0	6	855	NF	08	FRVE	14.0	679.0	2
801	NF	08	ACNE	10.0	410.0	6	856	NF	08	FRVE	15.0	151.0	6
802	NF	08	ACNE	10.0	308.0	6	857	NF	08	FRVE	15.0	198.0	6
803	NF	08	ACNE	10.0	310.0	6	858	NF	08	FRVE	16.0	181.0	6
804	NF	08	ACNE	11.0	432.0	6	859	NF	08	FRVE	19.0	125.0	6
805	NF	08	ACNE	11.0	310.0	6	860	NF	08	FRVE	22.0	228.0	6
806	NF	08	ACNE	11.0	309.0	6	861	NF	08	FRVE	32.0	1241.0	6
807	NF	08	ACNE	12.0	670.0	2	862	NF	08	FRVE	32.0	137.0	6
808	NF	08	ACNE	12.0	546.0	6	863	NF	08	FRVE	33.0	190.0	6
809	NF	08	ACNE	12.0	244.0	6	864	NF	08	FRVE	33.0	973.0	6
810	NF	08	ACNE	13.0	375.0	6	865	NF	08	FRVE	33.0	1250.0	6
811	NF	08	ACNE	14.0	190.0	6	866	NF	08	FRVE	43.0	71.0	6
812	NF	08	ACNE	14.0	36.0	6	867	NF	08	FRVE	46.0	223.0	6
813	NF	08	ACNE	15.0	426.0	6	868	NF	08	POFR	1.0	1492.0	6
814	NF	08	ACNE	15.0	383.0	6	869	NF	08	POFR	1.0	1506.0	6
815	NF	08	ACNE	17.0	784.0	6	870	NF	08	POFR	1.0	1507.0	6
816	NF	08	ACNE	19.0	133.0	6	871	NF	08	POFR	60.0	670.0	2
817	NF	08	ACNE	19.0	450.0	6	872	NF	09	ACNE	1.0	630.0	6
818	NF	08	ACNE	20.0	433.0	6	873	NF	09	ACNE	1.0	650.0	6
819	NF	08	ACNE	22.0	1209.0	6	874	NF	09	ACNE	1.0	630.0	6
820	NF	08	ACNE	23.0	100.0	6	875	NF	09	ACNE	1.0	797.0	6
821	NF	08	ACNE	23.0	784.0	6	876	NF	09	ACNE	1.0	806.0	6
822	NF	08	FRVE	1.0	1500.0	6	877	NF	09	ACNE	1.0	605.0	6
823	NF	08	FRVE	1.0	1507.0	6	878	NF	09	ACNE	1.0	805.0	6
824	NF	08	FRVE	1.0	1506.0	6	879	NF	09	ACNE	1.0	620.0	6
825	NF	08	FRVE	1.0	1514.0	6	880	NF	09	ACNE	1.0	620.0	6

Appendix B (Continued)
Raw Tree Data Set

Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code	Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code
881	NF	09	ACNE	1.0	805.0	6	936	NF	09	FRVE	1.0	600.0	6
882	NF	09	ACNE	2.0	1790.0	6	937	NF	09	FRVE	1.0	596.0	6
883	NF	09	ACNE	2.0	798.0	6	938	NF	09	FRVE	1.0	640.0	6
884	NF	09	ACNE	2.0	800.0	6	939	NF	09	FRVE	1.0	640.0	6
885	NF	09	ACNE	2.0	804.0	6	940	NF	09	FRVE	1.0	588.0	6
886	NF	09	ACNE	2.0	595.0	6	941	NF	09	FRVE	1.0	640.0	6
887	NF	09	ACNE	2.0	798.0	6	942	NF	09	FRVE	1.0	578.0	6
888	NF	09	ACNE	2.0	1780.0	6	943	NF	09	FRVE	1.0	600.0	6
889	NF	09	ACNE	2.0	797.0	6	944	NF	09	FRVE	1.0	600.0	6
890	NF	09	ACNE	2.0	800.0	6	945	NF	09	FRVE	1.0	595.0	6
891	NF	09	ACNE	2.0	1790.0	6	946	NF	09	FRVE	1.0	620.0	6
892	NF	09	ACNE	4.0	473.0	6	947	NF	09	FRVE	1.0	600.0	6
893	NF	09	ACNE	5.0	771.0	6	948	NF	09	FRVE	1.0	600.0	6
894	NF	09	ACNE	5.0	457.0	6	949	NF	09	FRVE	1.0	575.0	6
895	NF	09	ACNE	5.0	274.0	6	950	NF	09	FRVE	1.0	600.0	6
896	NF	09	ACNE	6.0	537.0	6	951	NF	09	FRVE	1.0	640.0	6
897	NF	09	ACNE	7.0	276.0	6	952	NF	09	FRVE	1.0	640.0	6
898	NF	09	ACNE	8.0	540.0	6	953	NF	09	FRVE	1.0	595.0	6
899	NF	09	ACNE	8.0	562.0	6	954	NF	09	FRVE	1.0	600.0	6
900	NF	09	ACNE	8.0	605.0	6	955	NF	09	FRVE	1.0	630.0	6
901	NF	09	ACNE	9.0	492.0	6	956	NF	09	FRVE	1.0	630.0	6
902	NF	09	ACNE	9.0	617.0	6	957	NF	09	FRVE	1.0	600.0	6
903	NF	09	ACNE	9.0	516.0	6	958	NF	09	FRVE	1.0	578.0	6
904	NF	09	ACNE	9.0	636.0	6	959	NF	09	FRVE	1.0	630.0	6
905	NF	09	ACNE	10.0	276.0	6	960	NF	09	FRVE	1.0	575.0	6
906	NF	09	ACNE	10.0	454.0	6	961	NF	09	FRVE	1.0	620.0	6
907	NF	09	ACNE	11.0	437.0	6	962	NF	09	FRVE	1.0	570.0	6
908	NF	09	ACNE	12.0	361.0	6	963	NF	09	FRVE	1.0	565.0	6
909	NF	09	ACNE	12.0	248.0	6	964	NF	09	FRVE	1.0	587.0	6
910	NF	09	ACNE	12.0	411.0	6	965	NF	09	FRVE	1.0	620.0	6
911	NF	09	ACNE	12.0	511.0	6	966	NF	09	FRVE	1.0	600.0	6
912	NF	09	ACNE	13.0	223.0	6	967	NF	09	FRVE	1.0	700.0	6
913	NF	09	ACNE	13.0	478.0	6	968	NF	09	FRVE	1.0	630.0	6
914	NF	09	ACNE	13.0	220.0	6	969	NF	09	FRVE	1.0	620.0	6
915	NF	09	ACNE	14.0	819.0	6	970	NF	09	FRVE	1.0	700.0	6
916	NF	09	ACNE	14.0	45.0	6	971	NF	09	FRVE	1.0	581.0	6
917	NF	09	ACNE	16.0	1123.0	6	972	NF	09	FRVE	1.0	640.0	6
918	NF	09	ACNE	17.0	824.0	6	973	NF	09	FRVE	1.0	640.0	6
919	NF	09	ACNE	20.0	238.0	6	974	NF	09	FRVE	1.0	640.0	6
920	NF	09	ACNE	24.0	410.0	6	975	NF	09	FRVE	1.0	588.0	6
921	NF	09	ACNE	25.0	1123.0	6	976	NF	09	FRVE	1.0	570.0	6
922	NF	09	ACNE	28.0	238.0	6	977	NF	09	FRVE	1.0	640.0	6
923	NF	09	ACNE	34.0	1123.0	6	978	NF	09	FRVE	1.0	578.0	6
924	NF	09	ACNE	37.0	43.0	6	979	NF	09	FRVE	1.0	700.0	6
925	NF	09	FRVE	1.0	640.0	6	980	NF	09	FRVE	1.0	565.0	6
926	NF	09	FRVE	1.0	575.0	6	981	NF	09	FRVE	1.0	600.0	6
927	NF	09	FRVE	1.0	630.0	6	982	NF	09	FRVE	1.0	570.0	6
928	NF	09	FRVE	1.0	620.0	6	983	NF	09	FRVE	1.0	596.0	6
929	NF	09	FRVE	1.0	630.0	6	984	NF	09	FRVE	1.0	700.0	6
930	NF	09	FRVE	1.0	596.0	6	985	NF	09	FRVE	1.0	581.0	6
931	NF	09	FRVE	1.0	578.0	6	986	NF	09	FRVE	1.0	600.0	6
932	NF	09	FRVE	1.0	595.0	6	987	NF	09	FRVE	1.0	596.0	6
933	NF	09	FRVE	1.0	600.0	6	988	NF	09	FRVE	1.0	700.0	6
934	NF	09	FRVE	1.0	700.0	6	989	NF	09	FRVE	1.0	620.0	6
935	NF	09	FRVE	1.0	640.0	6	990	NF	09	FRVE	1.0	640.0	6

Appendix B (Continued)
Raw Tree Data Set

Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code	Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code
991	NF	09	FRVE	1.0	600.0	6	1046	NF	09	FRVE	1.0	630.0	6
992	NF	09	FRVE	1.0	570.0	6	1047	NF	09	FRVE	1.0	630.0	6
993	NF	09	FRVE	1.0	620.0	6	1048	NF	09	FRVE	1.0	640.0	6
994	NF	09	FRVE	1.0	596.0	6	1049	NF	09	FRVE	1.0	600.0	6
995	NF	09	FRVE	1.0	600.0	6	1050	NF	09	FRVE	1.0	600.0	6
996	NF	09	FRVE	1.0	600.0	6	1051	NF	09	FRVE	1.0	720.0	6
997	NF	09	FRVE	1.0	600.0	6	1052	NF	09	FRVE	1.0	600.0	6
998	NF	09	FRVE	1.0	600.0	6	1053	NF	09	FRVE	2.0	1790.0	6
999	NF	09	FRVE	1.0	600.0	6	1054	NF	09	FRVE	2.0	1790.0	6
1000	NF	09	FRVE	1.0	600.0	6	1055	NF	09	FRVE	2.0	610.0	6
1001	NF	09	FRVE	1.0	640.0	6	1056	NF	09	FRVE	20.0	318.0	6
1002	NF	09	FRVE	1.0	600.0	6	1057	NF	09	FRVE	33.0	438.0	6
1003	NF	09	FRVE	1.0	700.0	6	1058	NF	09	FRVE	33.0	948.0	6
1004	NF	09	FRVE	1.0	581.0	6	1059	NF	09	FRVE	35.0	785.0	6
1005	NF	09	FRVE	1.0	600.0	6	1060	NF	09	FRVE	40.0	789.0	6
1006	NF	09	FRVE	1.0	630.0	6	1061	NF	09	POFR	1.0	600.0	6
1007	NF	09	FRVE	1.0	620.0	6	1062	NF	09	POFR	1.0	600.0	6
1008	NF	09	FRVE	1.0	600.0	6	1063	NF	10	ACNE	2.0	735.0	6
1009	NF	09	FRVE	1.0	600.0	6	1064	NF	10	ACNE	2.0	734.0	6
1010	NF	09	FRVE	1.0	620.0	6	1065	NF	10	ACNE	2.0	733.0	6
1011	NF	09	FRVE	1.0	600.0	6	1066	NF	10	ACNE	2.0	733.0	6
1012	NF	09	FRVE	1.0	600.0	6	1067	NF	10	ACNE	3.0	506.0	6
1013	NF	09	FRVE	1.0	600.0	6	1068	NF	10	ACNE	3.0	503.0	6
1014	NF	09	FRVE	1.0	640.0	6	1069	NF	10	ACNE	3.0	63.0	6
1015	NF	09	FRVE	1.0	630.0	6	1070	NF	10	ACNE	3.0	745.0	6
1016	NF	09	FRVE	1.0	640.0	6	1071	NF	10	ACNE	3.0	778.0	3
1017	NF	09	FRVE	1.0	640.0	6	1072	NF	10	ACNE	3.0	770.0	6
1018	NF	09	FRVE	1.0	720.0	6	1073	NF	10	ACNE	7.0	503.0	6
1019	NF	09	FRVE	1.0	620.0	6	1074	NF	10	ACNE	9.0	60.0	6
1020	NF	09	FRVE	1.0	600.0	6	1075	NF	10	ACNE	10.0	180.0	6
1021	NF	09	FRVE	1.0	595.0	6	1076	NF	10	ACNE	10.0	180.0	6
1022	NF	09	FRVE	1.0	600.0	6	1077	NF	10	ACNE	11.0	745.0	6
1023	NF	09	FRVE	1.0	600.0	6	1078	NF	10	ACNE	12.0	690.0	6
1024	NF	09	FRVE	1.0	700.0	6	1079	NF	10	ACNE	13.0	1000.0	6
1025	NF	09	FRVE	1.0	600.0	6	1080	NF	10	ACNE	15.0	200.0	6
1026	NF	09	FRVE	1.0	640.0	6	1081	NF	10	ACNE	15.0	200.0	6
1027	NF	09	FRVE	1.0	620.0	6	1082	NF	10	ACNE	17.0	690.0	6
1028	NF	09	FRVE	1.0	600.0	6	1083	NF	10	ACNE	19.0	60.0	6
1029	NF	09	FRVE	1.0	620.0	6	1084	NF	10	ACNE	20.0	170.0	6
1030	NF	09	FRVE	1.0	600.0	6	1085	NF	10	ACNE	22.0	1400.0	6
1031	NF	09	FRVE	1.0	620.0	6	1086	NF	10	ACNE	23.0	170.0	6
1032	NF	09	FRVE	1.0	600.0	6	1087	NF	10	ACNE	24.0	60.0	6
1033	NF	09	FRVE	1.0	620.0	6	1088	NF	10	ACNE	25.0	876.0	6
1034	NF	09	FRVE	1.0	575.0	6	1089	NF	10	ACNE	27.0	380.0	6
1035	NF	09	FRVE	1.0	600.0	6	1090	NF	10	FRVE	1.0	1757.0	6
1036	NF	09	FRVE	1.0	640.0	6	1091	NF	10	FRVE	1.0	1757.0	6
1037	NF	09	FRVE	1.0	640.0	6	1092	NF	10	FRVE	2.0	737.0	6
1038	NF	09	FRVE	1.0	600.0	6	1093	NF	10	FRVE	2.0	763.0	6
1039	NF	09	FRVE	1.0	588.0	6	1094	NF	10	FRVE	3.0	733.0	6
1040	NF	09	FRVE	1.0	640.0	6	1095	NF	10	FRVE	3.0	763.0	6
1041	NF	09	FRVE	1.0	578.0	6	1096	NF	10	FRVE	3.0	733.0	3
1042	NF	09	FRVE	1.0	587.0	6	1097	NF	10	FRVE	4.0	749.0	6
1043	NF	09	FRVE	1.0	596.0	6	1098	NF	10	FRVE	4.0	734.0	6
1044	NF	09	FRVE	1.0	600.0	6	1099	NF	10	FRVE	5.0	734.0	6
1045	NF	09	FRVE	1.0	640.0	6	1100	NF	10	FRVE	7.0	737.0	6

Appendix B (Continued)
Raw Tree Data Set

Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code	Record No.	Stream	Transect	Species	DBH (cm)	Distance (dm)	Substrate Code
1101	NF	10	FRVE	9.0	735.0	6	1113	NF	10	FRVE	26.0	1000.0	6
1102	NF	10	FRVE	9.0	738.0	6	1114	NF	10	FRVE	28.0	183.0	6
1103	NF	10	FRVE	11.0	1000.0	6	1115	NF	10	FRVE	29.0	960.0	6
1104	NF	10	FRVE	12.0	810.0	6	1116	NF	10	FRVE	30.0	180.0	6
1105	NF	10	FRVE	13.0	740.0	6	1117	NF	10	FRVE	36.0	1800.0	3
1106	NF	10	FRVE	15.0	810.0	6	1118	NF	10	FRVE	40.0	810.0	6
1107	NF	10	FRVE	18.0	959.0	6	1119	NF	10	FRVE	41.0	1000.0	6
1108	NF	10	FRVE	21.0	787.0	6	1120	NF	10	FRVE	48.0	1800.0	3
1109	NF	10	FRVE	22.0	1002.0	6	1121	NF	10	FRVE	50.0	740.0	6
1110	NF	10	FRVE	22.0	960.0	6	1122	NF	10	FRVE	53.0	180.0	6
1111	NF	10	FRVE	24.0	740.0	6	1123	NF	10	FRVE	67.0	180.0	6
1112	NF	10	FRVE	25.0	960.0	6	1124	NF	10	POFR	71.0	1450.0	6

APPENDIX C

Raw Herb Cover Data Set

Appendix C
Raw Herb Cover Data Set

Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code	Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code
1	EF	01	AMAC	2.0	70.0	6	56	EF	02	SCPU	75.0	330.0	6
2	EF	01	EQLA	3.0	120.0	6	57	EF	02	SCPU	5.0	350.0	6
3	EF	01	EQLA	2.0	150.0	6	58	EF	02	EQLA	2.0	400.0	6
4	EF	01	SCPU	15.0	170.0	6	59	EF	02	BRTE	70.0	450.0	6
5	EF	01	H2O	.	200.0	4	60	EF	02	BRTE	15.0	500.0	6
6	EF	01	H2O	.	250.0	5	61	EF	02	MOSS	10.0	500.0	6
7	EF	01	H2O	.	280.0	5	62	EF	02	SCSC	3.0	500.0	6
8	EF	01	EQAR	1.0	300.0	6	63	EF	02	BRTE	40.0	550.0	6
9	EF	01	EQLA	10.0	300.0	6	64	EF	02	LIAR	2.0	550.0	6
10	EF	01	JUBA	15.0	300.0	6	65	EF	02	MOSS	2.0	550.0	6
11	EF	01	AMAC	1.0	400.0	6	66	EF	02	BRTE	15.0	600.0	6
12	EF	01	IPCOF	1.0	400.0	6	67	EF	02	PSLA	25.0	600.0	6
13	EF	01	BRTE	5.0	450.0	6	68	EF	02	BRTE	40.0	650.0	6
14	EF	01	ORHY	2.0	450.0	6	69	EF	02	PSLA	20.0	650.0	6
15	EF	01	ORHY	10.0	500.0	6	70	EF	02	SPCR	5.0	650.0	6
16	EF	01	PSLA	10.0	500.0	6	71	EF	02	BRTE	30.0	700.0	6
17	EF	01	ORHY	20.0	550.0	6	72	EF	02	PSLA	35.0	700.0	6
18	EF	01	SPCR	15.0	550.0	6	73	EF	02	SPCR	15.0	700.0	6
19	EF	01	ARLO	10.0	600.0	6	74	EF	02	BRTE	35.0	750.0	6
20	EF	01	ASMI	1.0	600.0	6	75	EF	02	PSLA	15.0	750.0	6
21	EF	01	BRTE	5.0	600.0	6	76	EF	02	ARLO	20.0	800.0	6
22	EF	01	MOSS	45.0	600.0	6	77	EF	02	BRTE	20.0	800.0	6
23	EF	01	PSLA	10.0	600.0	6	78	EF	02	MOSS	15.0	800.0	6
24	EF	01	SPCR	5.0	600.0	6	79	EF	02	PSLA	10.0	800.0	6
25	EF	01	ARLO	10.0	700.0	5	80	EF	02	SPCR	8.0	800.0	6
26	EF	01	PSLA	10.0	700.0	5	81	EF	02	ARLO	30.0	850.0	6
27	EF	01	SPCR	5.0	700.0	5	82	EF	02	BRTE	20.0	850.0	6
28	EF	01	ARLO	35.0	750.0	5	83	EF	02	MOSS	45.0	850.0	6
29	EF	01	BRTE	40.0	800.0	6	84	EF	02	ORHY	2.0	850.0	6
30	EF	01	BRTE	20.0	850.0	6	85	EF	02	ARLO	10.0	900.0	6
31	EF	01	SPCR	30.0	850.0	6	86	EF	02	BRTE	30.0	900.0	6
32	EF	01	BRTE	70.0	900.0	6	87	EF	02	MOSS	60.0	900.0	6
33	EF	01	ARLO	15.0	950.0	6	88	EF	02	ARLO	15.0	950.0	6
34	EF	01	ARLU	45.0	950.0	6	89	EF	02	BRTE	35.0	950.0	6
35	EF	01	BRTE	20.0	950.0	6	90	EF	02	MOSS	5.0	950.0	6
36	EF	01	MOSS	3.0	950.0	6	91	EF	02	SPCO	30.0	950.0	6
37	EF	01	BRTE	20.0	1000.0	6	92	EF	02	BRTE	80.0	1000.0	6
38	EF	01	SPCO	65.0	1000.0	6	93	EF	02	SPCO	5.0	1000.0	6
39	EF	01	BRTE	40.0	1050.0	6	94	EF	02	BRTE	45.0	1050.0	6
40	EF	02	BRTE	15.0	50.0	6	95	EF	02	SPCO	10.0	1050.0	6
41	EF	02	MACA	15.0	50.0	6	96	EF	02	BRTE	55.0	1100.0	6
42	EF	02	AMAC	10.0	100.0	6	97	EF	02	SPCO	30.0	1100.0	6
43	EF	02	BRTE	20.0	100.0	6	98	EF	02	BRTE	45.0	1150.0	6
44	EF	02	MACA	15.0	100.0	6	99	EF	02	SPCO	15.0	1150.0	6
45	EF	02	ARLO	30.0	150.0	6	100	EF	03	BRTE	35.0	50.0	6
46	EF	02	BRTE	5.0	150.0	6	101	EF	03	PSLA	10.0	50.0	6
47	EF	02	ERSP	2.0	200.0	5	102	EF	03	BRTE	25.0	100.0	6
48	EF	02	LIAR	2.0	200.0	5	103	EF	03	PSLA	30.0	100.0	6
49	EF	02	STPA	15.0	200.0	5	104	EF	03	BRTE	35.0	150.0	6
50	EF	02	EQLA	15.0	240.0	6	105	EF	03	PSLA	3.0	150.0	6
51	EF	02	SCPU	40.0	240.0	6	106	EF	03	SPCR	15.0	150.0	6
52	EF	02	H2O	.	260.0	4	107	EF	03	BRTE	20.0	200.0	5
53	EF	02	H2O	.	300.0	4	108	EF	03	PSLA	30.0	200.0	5
54	EF	02	EQLA	15.0	330.0	6	109	EF	03	BRTE	10.0	250.0	6
55	EF	02	MEAL	2.0	330.0	6	110	EF	03	PSLA	5.0	250.0	6

Appendix C (Continued)
Raw Herb Cover Data Set

Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code	Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code
111	EF	03	BRTE	5.0	300.0	6	166	EF	04	BRTE	15.0	200.0	6
112	EF	03	PSLA	5.0	300.0	6	167	EF	04	MUSQ	15.0	200.0	6
113	EF	03	BRTE	5.0	350.0	6	168	EF	04	SPCR	5.0	200.0	6
114	EF	03	PSLA	10.0	350.0	6	169	EF	04	BRTE	5.0	250.0	5
115	EF	03	BRTE	5.0	400.0	7	170	EF	04	ARLO	15.0	300.0	6
116	EF	03	BRTE	5.0	450.0	7	171	EF	04	BRTE	15.0	300.0	6
117	EF	03	PSLA	5.0	450.0	7	172	EF	04	ARLO	8.0	350.0	6
118	EF	03	ARLO	15.0	500.0	5	173	EF	04	BRTE	10.0	350.0	6
119	EF	03	MACA	3.0	500.0	5	174	EF	04	ERSP	1.0	350.0	6
120	EF	03	PSLA	5.0	500.0	5	175	EF	04	HYFI	3.0	350.0	6
121	EF	03	ARLO	30.0	550.0	5	176	EF	04	PSLA	10.0	350.0	6
122	EF	03	BRTE	15.0	550.0	5	177	EF	04	BRTE	10.0	400.0	6
123	EF	03	PSLA	10.0	550.0	5	178	EF	04	MACA	5.0	400.0	6
124	EF	03	BRTE	15.0	600.0	6	179	EF	04	PSLA	10.0	400.0	6
125	EF	03	LIAR	2.0	600.0	6	180	EF	04	SPCR	5.0	400.0	6
126	EF	03	PSLA	15.0	600.0	6	181	EF	04	IPLO	1.0	450.0	6
127	EF	03	BRTE	40.0	650.0	6	182	EF	04	LIAR	2.0	450.0	6
128	EF	03	MEAL	5.0	700.0	6	183	EF	04	PSLA	25.0	450.0	6
129	EF	03	MUAS	15.0	700.0	6	184	EF	04	BRTE	10.0	500.0	6
130	EF	03	SCPU	5.0	700.0	6	185	EF	04	TOIN	1.0	500.0	6
131	EF	03	SCPU	45.0	720.0	6	186	EF	04	SPCR	3.0	550.0	6
132	EF	03	H2O	.	740.0	4	187	EF	04	BRTE	15.0	600.0	5
133	EF	03	H2O	.	800.0	4	188	EF	04	HYFI	4.0	600.0	5
134	EF	03	H2O	.	820.0	5	189	EF	04	AMAC	2.0	650.0	6
135	EF	03	SCPU	35.0	840.0	6	190	EF	04	BRTE	10.0	650.0	6
136	EF	03	MEAL	5.0	880.0	6	191	EF	04	ERSP	1.0	650.0	6
137	EF	03	EQLA	1.0	950.0	6	192	EF	04	MEAL	2.0	650.0	6
138	EF	03	BRTE	25.0	1000.0	6	193	EF	04	SPCR	5.0	650.0	6
139	EF	03	PSLA	5.0	1000.0	6	194	EF	04	ARLO	5.0	700.0	5
140	EF	03	SESP	15.0	1000.0	6	195	EF	04	MEAL	15.0	750.0	3
141	EF	03	SPCR	25.0	1000.0	6	196	EF	04	AMAC	1.0	800.0	6
142	EF	03	BRTE	25.0	1050.0	6	197	EF	04	MOSS	45.0	800.0	6
143	EF	03	PSLA	3.0	1050.0	6	198	EF	04	ORHY	10.0	800.0	6
144	EF	03	SPCR	10.0	1050.0	6	199	EF	04	BRTE	2.0	850.0	6
145	EF	03	BRTE	25.0	1100.0	6	200	EF	04	LIAR	1.0	850.0	6
146	EF	03	PSLA	35.0	1100.0	6	201	EF	04	MOSS	35.0	850.0	6
147	EF	03	SPCR	10.0	1100.0	6	202	EF	04	H2O	.	1100.0	4
148	EF	03	BRTE	20.0	1150.0	6	203	EF	04	MUAS	5.0	1140.0	6
149	EF	03	ORHY	10.0	1150.0	6	204	EF	04	SCPU	35.0	1140.0	6
150	EF	03	PSLA	25.0	1150.0	6	205	EF	04	PSLA	5.0	1170.0	6
151	EF	03	BRTE	10.0	1200.0	6	206	EF	04	ASMI	1.0	1200.0	6
152	EF	03	PSLA	15.0	1200.0	6	207	EF	04	LIAR	2.0	1200.0	6
153	EF	03	SPCR	25.0	1200.0	6	208	EF	04	PSLA	15.0	1200.0	6
154	EF	03	BRTE	40.0	1250.0	6	209	EF	05	BRTE	35.0	20.0	6
155	EF	03	MACA	1.0	1250.0	6	210	EF	05	SPCO	15.0	20.0	6
156	EF	03	PSLA	15.0	1250.0	6	211	EF	05	BRTE	80.0	50.0	6
157	EF	03	SPCO	10.0	1250.0	6	212	EF	05	AMAC	1.0	100.0	6
158	EF	04	BRTE	15.0	50.0	6	213	EF	05	BRTE	10.0	100.0	6
159	EF	04	SAKA	55.0	50.0	6	214	EF	05	MUSQ	10.0	100.0	6
160	EF	04	BRTE	15.0	100.0	6	215	EF	05	ARLO	20.0	150.0	6
161	EF	04	MUSQ	30.0	100.0	6	216	EF	05	ARLO	20.0	200.0	6
162	EF	04	SPCO	2.0	100.0	6	217	EF	05	ARLO	2.0	250.0	6
163	EF	04	BRTE	15.0	150.0	6	218	EF	05	BRTE	4.0	250.0	6
164	EF	04	MUSQ	15.0	150.0	6	219	EF	05	OEPA	1.0	250.0	6
165	EF	04	OEPA	20.0	150.0	6	220	EF	05	ARLO	15.0	300.0	6

Appendix C (Continued)
Raw Herb Cover Data Set

Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code	Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code
221	EF	05	BRTE	14.0	300.0	6	276	EF	05	HYFI	2.0	1600.0	6
222	EF	05	SPCO	5.0	300.0	6	277	EF	05	MACA	15.0	1600.0	6
223	EF	05	ARLO	2.0	350.0	6	278	EF	05	PSLA	20.0	1600.0	6
224	EF	05	BRTE	5.0	350.0	6	279	EF	05	SPCO	25.0	1600.0	6
225	EF	05	MOSS	5.0	350.0	6	280	EF	06	BRTE	35.0	50.0	6
226	EF	05	AMAC	1.0	400.0	6	281	EF	06	MUSQ	5.0	50.0	6
227	EF	05	ARLO	10.0	400.0	6	282	EF	06	OEPA	1.0	50.0	6
228	EF	05	SPCR	1.0	400.0	6	283	EF	06	BRTE	5.0	100.0	6
229	EF	05	AMAC	1.0	450.0	6	284	EF	06	SPCR	1.0	150.0	6
230	EF	05	ARLO	15.0	450.0	6	285	EF	06	EQLA	5.0	270.0	6
231	EF	05	MOSS	35.0	450.0	6	286	EF	06	SCPU	35.0	280.0	6
232	EF	05	ARLO	10.0	500.0	6	287	EF	06	H2O	.	300.0	5
233	EF	05	BRTE	10.0	500.0	6	288	EF	06	H2O	.	350.0	5
234	EF	05	AMAC	1.0	550.0	6	289	EF	06	SCPU	45.0	390.0	6
235	EF	05	ARLO	3.0	550.0	6	290	EF	06	HEVI	10.0	430.0	6
236	EF	05	HYFI	1.0	550.0	6	291	EF	06	IPCOF	10.0	430.0	6
237	EF	05	AGAL	1.0	640.0	6	292	EF	06	MEAL	3.0	430.0	6
238	EF	05	SCPU	40.0	640.0	6	293	EF	06	IPCOF	25.0	450.0	6
239	EF	05	H2O	.	700.0	3	294	EF	06	BRTE	15.0	500.0	6
240	EF	05	H2O	.	750.0	3	295	EF	06	ARLO	15.0	550.0	6
241	EF	05	SCPU	15.0	780.0	6	296	EF	06	PSLA	20.0	550.0	6
242	EF	05	SCPU	25.0	800.0	6	297	EF	06	SPFL	10.0	600.0	6
243	EF	05	MEAL	5.0	820.0	6	298	EF	06	PSLA	15.0	650.0	6
244	EF	05	MUAS	10.0	820.0	6	299	EF	06	SPCO	5.0	650.0	6
245	EF	05	SCPU	10.0	820.0	6	300	EF	06	BRTE	25.0	700.0	6
246	EF	05	MEAL	10.0	840.0	6	301	EF	06	PSLA	25.0	700.0	6
247	EF	05	MUAS	15.0	840.0	6	302	EF	06	SPFL	5.0	700.0	6
248	EF	05	IPCOF	5.0	900.0	6	303	EF	06	BRTE	25.0	800.0	6
249	EF	05	PSLA	15.0	900.0	6	304	EF	06	PSLA	35.0	800.0	6
250	EF	05	BRTE	35.0	950.0	6	305	EF	06	PSLA	30.0	900.0	6
251	EF	05	PSLA	10.0	950.0	6	306	EF	06	SPCO	10.0	900.0	6
252	EF	05	PSLA	10.0	1000.0	6	307	EF	06	SPFL	10.0	900.0	6
253	EF	05	SPCR	20.0	1000.0	6	308	EF	06	MOSS	25.0	1000.0	6
254	EF	05	BRTE	3.0	1050.0	6	309	EF	06	PSLA	25.0	1000.0	6
255	EF	05	LIAR	2.0	1050.0	6	310	EF	06	SPCO	15.0	1000.0	6
256	EF	05	MOSS	40.0	1050.0	6	311	EF	06	BRTE	15.0	1050.0	6
257	EF	05	PSLA	20.0	1050.0	6	312	EF	06	PSLA	25.0	1050.0	6
258	EF	05	BRTE	2.0	1100.0	6	313	EF	06	SPCO	25.0	1050.0	6
259	EF	05	MOSS	25.0	1100.0	6	314	EF	06	BRTE	15.0	1150.0	6
260	EF	05	BRTE	40.0	1200.0	6	315	EF	06	PSLA	10.0	1150.0	6
261	EF	05	SPCO	25.0	1200.0	6	316	EF	06	SPFL	30.0	1150.0	6
262	EF	05	BRTE	35.0	1250.0	6	317	EF	06	MOSS	40.0	1200.0	6
263	EF	05	SPCO	30.0	1250.0	6	318	EF	06	PLPA	2.0	1200.0	6
264	EF	05	BRTE	25.0	1300.0	6	319	EF	06	SPCO	10.0	1200.0	6
265	EF	05	MOSS	50.0	1300.0	6	320	EF	06	SPFL	35.0	1200.0	6
266	EF	05	BRTE	5.0	1400.0	6	321	EF	06	SPFL	35.0	1300.0	6
267	EF	05	MACA	5.0	1400.0	6	322	EF	06	BRTE	25.0	1400.0	6
268	EF	05	PSLA	5.0	1400.0	6	323	EF	07	ORHY	5.0	100.0	6
269	EF	05	SPCO	10.0	1400.0	6	324	EF	07	BRTE	5.0	150.0	4
270	EF	05	SPCR	15.0	1400.0	6	325	EF	07	ARLO	5.0	200.0	5
271	EF	05	BRTE	5.0	1500.0	6	326	EF	07	BRTE	5.0	200.0	5
272	EF	05	MACA	2.0	1500.0	6	327	EF	07	SCPU	15.0	240.0	6
273	EF	05	PSLA	25.0	1500.0	6	328	EF	07	H2O	.	260.0	2
274	EF	05	SPCR	10.0	1500.0	6	329	EF	07	H2O	.	300.0	4
275	EF	05	BRTE	5.0	1600.0	6	330	EF	07	MEIN	1.0	350.0	6

Appendix C (Continued)
Raw Herb Cover Data Set

Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code	Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code
331	EF	07	SCPU	1.0	350.0	6	386	EF	08	LIAR	1.0	250.0	6
332	EF	07	MEAL	10.0	380.0	6	387	EF	08	SPFL	2.0	250.0	6
333	EF	07	EQLA	1.0	400.0	6	388	EF	08	EQAR	10.0	340.0	6
334	EF	07	AMAC	1.0	450.0	6	389	EF	08	MEAL	30.0	340.0	6
335	EF	07	EQLA	1.0	450.0	6	390	EF	08	SCPU	35.0	340.0	6
336	EF	07	PSLA	35.0	550.0	6	391	EF	08	H2O	.	400.0	5
337	EF	07	EQLA	2.0	600.0	6	392	EF	08	H2O	.	420.0	5
338	EF	07	MACA	3.0	600.0	6	393	EF	08	AGTR	2.0	440.0	6
339	EF	07	PSLA	10.0	600.0	6	394	EF	08	EQLA	5.0	440.0	6
340	EF	07	ARLO	2.0	700.0	6	395	EF	08	MEAL	2.0	440.0	6
341	EF	07	PSLA	2.0	700.0	6	396	EF	08	MUAS	1.0	440.0	6
342	EF	07	TOIN	3.0	700.0	6	397	EF	08	SCPU	15.0	440.0	6
343	EF	07	BRTE	4.0	800.0	6	398	EF	08	PSLA	15.0	520.0	6
344	EF	07	MOSS	20.0	800.0	6	399	EF	08	PSLA	20.0	550.0	6
345	EF	07	PSLA	10.0	800.0	6	400	EF	08	PSLA	20.0	700.0	6
346	EF	07	SPFL	15.0	800.0	6	401	EF	08	BRTE	60.0	750.0	6
347	EF	07	BRTE	10.0	900.0	6	402	NF	01	BRDI	80.0	50.0	6
348	EF	07	PSLA	10.0	900.0	6	403	NF	01	BRDI	80.0	50.0	6
349	EF	07	SPFL	25.0	900.0	6	404	NF	01	BRDI	85.0	100.0	6
350	EF	07	BRTE	20.0	1000.0	6	405	NF	01	SPCO	5.0	100.0	6
351	EF	07	PSLA	15.0	1000.0	6	406	NF	01	MUAS	80.0	150.0	6
352	EF	07	SPFL	35.0	1000.0	6	407	NF	01	POPR	20.0	150.0	6
353	EF	07	BRTE	15.0	1050.0	6	408	NF	01	BRDI	15.0	200.0	6
354	EF	07	PSLA	40.0	1050.0	6	409	NF	01	MUAS	80.0	200.0	6
355	EF	07	SPFL	20.0	1050.0	6	410	NF	01	BRDI	10.0	250.0	6
356	EF	07	BRTE	45.0	1150.0	6	411	NF	01	HEVI	30.0	250.0	6
357	EF	07	PSLA	10.0	1150.0	6	412	NF	01	MUAS	35.0	250.0	6
358	EF	07	SPCO	5.0	1150.0	6	413	NF	01	SPCO	5.0	250.0	6
359	EF	07	SPFL	10.0	1150.0	6	414	NF	01	BRDI	10.0	300.0	6
360	EF	07	BRTE	99.0	1200.0	6	415	NF	01	HEVI	15.0	300.0	6
361	EF	08	MOSS	2.0	50.0	6	416	NF	01	SPCO	40.0	300.0	6
362	EF	08	OEPA	10.0	50.0	6	417	NF	01	SPCR	5.0	300.0	6
363	EF	08	PSLA	5.0	50.0	6	418	NF	01	BRDI	10.0	350.0	6
364	EF	08	SPFL	35.0	50.0	6	419	NF	01	HEVI	10.0	350.0	6
365	EF	08	BRTE	10.0	70.0	6	420	NF	01	SPCO	15.0	350.0	6
366	EF	08	SPFL	15.0	70.0	6	421	NF	01	SPCR	40.0	350.0	6
367	EF	08	ARLO	10.0	100.0	6	422	NF	01	OEPA	1.0	400.0	6
368	EF	08	BRTE	15.0	100.0	6	423	NF	01	SESP	2.0	400.0	6
369	EF	08	MOSS	10.0	100.0	6	424	NF	01	SPCR	20.0	400.0	6
370	EF	08	SPFL	25.0	100.0	6	425	NF	01	HEVI	30.0	450.0	6
371	EF	08	ARLO	5.0	120.0	3	426	NF	01	BRDI	1.0	500.0	6
372	EF	08	BRTE	10.0	120.0	3	427	NF	01	HEVI	20.0	500.0	6
373	EF	08	SPFL	15.0	120.0	3	428	NF	01	FEEL	90.0	550.0	6
374	EF	08	ARLO	20.0	150.0	5	429	NF	01	JUBA	5.0	550.0	6
375	EF	08	OEPA	5.0	150.0	5	430	NF	01	BRDI	5.0	600.0	6
376	EF	08	SPFL	30.0	150.0	5	431	NF	01	BRTE	80.0	600.0	6
377	EF	08	ARLO	10.0	170.0	5	432	NF	01	MUAS	5.0	600.0	6
378	EF	08	ASMI	5.0	170.0	5	433	NF	01	ARLU	5.0	650.0	6
379	EF	08	BRTE	5.0	200.0	5	434	NF	01	BRTE	10.0	650.0	6
380	EF	08	ERSP	2.0	200.0	5	435	NF	01	HEVI	10.0	650.0	6
381	EF	08	BRTE	10.0	220.0	5	436	NF	01	SPCR	10.0	650.0	6
382	EF	08	ERSP	1.0	220.0	5	437	NF	01	HEVI	15.0	700.0	6
383	EF	08	SPFL	15.0	220.0	5	438	NF	01	SPCR	5.0	700.0	6
384	EF	08	AMAC	1.0	250.0	6	439	NF	01	AGTR	40.0	750.0	6
385	EF	08	ERSP	1.0	250.0	6	440	NF	01	HEVI	20.0	750.0	6

Appendix C (Continued)
Raw Herb Cover Data Set

Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code	Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code
441	NF	01	BRDI	10.0	800.0	6	496	NF	02	SPCR	20.0	150.0	6
442	NF	01	EQLA	10.0	800.0	6	497	NF	02	HEVI	5.0	200.0	6
443	NF	01	MUAS	5.0	800.0	6	498	NF	02	SESP	15.0	200.0	6
444	NF	01	AGAL	25.0	850.0	6	499	NF	02	SPCR	5.0	200.0	6
445	NF	01	EUOC	3.0	850.0	6	500	NF	02	AGAL	5.0	220.0	6
446	NF	01	POGL	10.0	850.0	6	501	NF	02	AGTR	5.0	220.0	6
447	NF	01	AGAL	35.0	860.0	6	502	NF	02	FEEL	20.0	220.0	6
448	NF	01	BRTE	3.0	860.0	6	503	NF	02	SCPU	10.0	220.0	6
449	NF	01	EUOC	5.0	860.0	6	504	NF	02	H2O	.	250.0	4
450	NF	01	JUBA	5.0	860.0	6	505	NF	02	AGAL	15.0	300.0	6
451	NF	01	MEOF	5.0	860.0	6	506	NF	02	EQAR	5.0	300.0	6
452	NF	01	AGAL	15.0	870.0	4	507	NF	02	EQLA	35.0	300.0	6
453	NF	01	EQLA	5.0	870.0	4	508	NF	02	FEEL	15.0	300.0	6
454	NF	01	JUBA	10.0	870.0	4	509	NF	02	RACYS	4.0	300.0	6
455	NF	01	H2O	.	900.0	6	510	NF	02	RUCR	2.0	300.0	6
456	NF	01	H2O	.	950.0	6	511	NF	02	TYDO	12.0	300.0	6
457	NF	01	AGAL	2.0	1000.0	6	512	NF	02	COCA	1.0	330.0	6
458	NF	01	EQLA	60.0	1000.0	6	513	NF	02	EQAR	10.0	330.0	6
459	NF	01	JUBA	15.0	1000.0	6	514	NF	02	EQLA	10.0	330.0	6
460	NF	01	SCMI	10.0	1000.0	6	515	NF	02	FEEL	15.0	330.0	6
461	NF	01	ASAS	2.0	1030.0	6	516	NF	02	JUENM	10.0	330.0	6
462	NF	01	EQLA	70.0	1030.0	6	517	NF	02	MEAL	5.0	330.0	6
463	NF	01	MEOF	3.0	1030.0	6	518	NF	02	MELU	1.0	330.0	6
464	NF	01	RACYS	3.0	1030.0	6	519	NF	02	MUAD	1.0	330.0	6
465	NF	01	SCMI	3.0	1030.0	6	520	NF	02	OELO	2.0	330.0	6
466	NF	01	TAOF	1.0	1030.0	6	521	NF	02	AGAL	10.0	350.0	4
467	NF	01	COCA	4.0	1050.0	6	522	NF	02	HEVI	3.0	350.0	4
468	NF	01	EQLA	25.0	1050.0	6	523	NF	02	MUAS	25.0	350.0	4
469	NF	01	JUENM	5.0	1050.0	6	524	NF	02	POPR	2.0	350.0	4
470	NF	01	MEAL	1.0	1050.0	6	525	NF	02	AGAL	5.0	400.0	6
471	NF	01	MEAR	2.0	1050.0	6	526	NF	02	EQLA	5.0	400.0	6
472	NF	01	MELU	1.0	1050.0	6	527	NF	02	ERDI	2.0	400.0	6
473	NF	01	AGAL	20.0	1070.0	6	528	NF	02	ERFL	1.0	400.0	6
474	NF	01	ARLU	10.0	1070.0	6	529	NF	02	MELU	1.0	400.0	6
475	NF	01	EQAR	3.0	1070.0	6	530	NF	02	MEOF	1.0	400.0	6
476	NF	01	EQLA	40.0	1070.0	6	531	NF	02	PHHE2	2.0	400.0	6
477	NF	01	FEEL	35.0	1070.0	6	532	NF	02	EPCI	2.0	450.0	6
478	NF	01	GNWR	1.0	1070.0	6	533	NF	02	EQAR	10.0	450.0	6
479	NF	01	SOAS	2.0	1070.0	6	534	NF	02	EQLA	20.0	450.0	6
480	NF	01	POPR	80.0	1100.0	6	535	NF	02	FEEL	45.0	450.0	6
481	NF	01	BRDI	10.0	1150.0	6	536	NF	02	JUBA	10.0	450.0	6
482	NF	01	SPCR	30.0	1150.0	6	537	NF	02	JUENM	4.0	450.0	6
483	NF	02	ARDR	15.0	10.0	6	538	NF	02	MELU	1.0	450.0	6
484	NF	02	BRDI	35.0	10.0	6	539	NF	02	SCPU	10.0	450.0	6
485	IF	02	HEVI	10.0	10.0	6	540	NF	02	AGAL	60.0	500.0	6
486	NF	02	MUAS	10.0	10.0	6	541	NF	02	EQLA	1.0	500.0	6
487	NF	02	SPCO	5.0	10.0	6	542	NF	02	MELU	3.0	500.0	6
488	NF	02	BRDI	15.0	50.0	6	543	NF	02	MUAS	5.0	500.0	6
489	NF	02	HEVI	20.0	50.0	6	544	NF	02	HEVI	1.0	550.0	6
490	NF	02	MUAS	30.0	50.0	6	545	NF	02	MELU	1.0	550.0	6
491	NF	02	BRDI	10.0	100.0	6	546	NF	02	AGAL	1.0	600.0	6
492	NF	02	HEVI	25.0	100.0	6	547	NF	02	HEVI	20.0	600.0	6
493	NF	02	HEVI	5.0	150.0	6	548	NF	02	SPCO	3.0	600.0	6
494	NF	02	MACA	5.0	150.0	6	549	NF	02	AGAL	70.0	650.0	6
495	NF	02	POGL	5.0	150.0	6	550	NF	02	BRTE	1.0	650.0	6

Appendix C (Continued)
Raw Herb Cover Data Set

Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code	Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code
551	NF	02	ELEL	5.0	650.0	6	606	NF	03	JUENM	15.0	450.0	6
552	NF	02	EQLA	1.0	650.0	6	607	NF	03	OELO	1.0	450.0	6
553	NF	02	POPR	3.0	650.0	6	608	NF	03	RACYS	4.0	450.0	6
554	NF	02	AGAL	60.0	700.0	6	609	NF	03	AGAL	3.0	500.0	6
555	NF	02	AGAL	5.0	700.0	4	610	NF	03	ERDI	2.0	500.0	6
556	NF	02	ARLU	3.0	700.0	6	611	NF	03	FEEL	5.0	500.0	6
557	NF	02	EQLA	5.0	700.0	6	612	NF	03	MEIN	3.0	500.0	6
558	NF	02	ERFL	3.0	700.0	4	613	NF	03	AGAL	10.0	550.0	4
559	NF	02	EUOC	1.0	700.0	6	614	NF	03	EQLA	1.0	550.0	4
560	NF	02	JUBA	5.0	700.0	6	615	NF	03	MEIN	4.0	550.0	4
561	NF	02	MEIN	2.0	700.0	4	616	NF	03	VETH	1.0	550.0	4
562	NF	02	MELU	3.0	700.0	4	617	NF	03	COCA	2.0	600.0	6
563	NF	02	MUAS	2.0	700.0	6	618	NF	03	HEVI	1.0	600.0	6
564	NF	02	SOMI	1.0	700.0	4	619	NF	03	POCO	2.0	600.0	6
565	NF	02	ASAS	2.0	800.0	6	620	NF	03	AGAL	5.0	650.0	4
566	NF	02	COCA	1.0	800.0	6	621	NF	03	EQLA	1.0	650.0	4
567	NF	02	EQLA	20.0	800.0	6	622	NF	03	ERZI	1.0	650.0	4
568	NF	02	JUEFB	15.0	800.0	6	623	NF	03	HEVI	3.0	650.0	4
569	NF	02	MUAS	15.0	800.0	6	624	NF	03	POCO	2.0	650.0	4
570	NF	02	RACYS	10.0	800.0	6	625	NF	03	AGAL	5.0	700.0	6
571	NF	02	AGAL	3.0	850.0	3	626	NF	03	BRIN	5.0	700.0	6
572	NF	02	ARLU	1.0	850.0	3	627	NF	03	EQLA	5.0	700.0	6
573	NF	02	EQAR	2.0	850.0	3	628	NF	03	HEVI	10.0	700.0	6
574	NF	02	EQLA	10.0	850.0	3	629	NF	03	BRDI	60.0	750.0	6
575	NF	02	JUEFB	2.0	850.0	3	630	NF	03	BRIN	3.0	750.0	6
576	NF	02	H2O	.	900.0	4	631	NF	03	HEVI	10.0	750.0	6
577	NF	02	H2O	.	950.0	6	632	NF	03	TRPO	1.0	750.0	6
578	NF	02	BRDI	99.0	1000.0	6	633	NF	03	BRDI	5.0	800.0	6
579	NF	02	BRDI	99.0	1050.0	6	634	NF	03	BRTE	10.0	800.0	6
580	NF	02	ARDR	5.0	1100.0	6	635	NF	03	HEVI	15.0	800.0	6
581	NF	02	BRDI	90.0	1100.0	6	636	NF	03	SPCR	60.0	800.0	6
582	NF	02	DAWR	1.0	1100.0	6	637	NF	03	BRDI	20.0	850.0	6
583	NF	02	BRDI	99.0	1150.0	4	638	NF	03	HEVI	5.0	850.0	6
584	NF	03	BRDI	80.0	20.0	6	639	NF	03	SPCO	10.0	850.0	6
585	NF	03	HEVI	15.0	20.0	6	640	NF	03	SPCR	10.0	850.0	6
586	NF	03	BRDI	25.0	50.0	6	641	NF	03	VETH	3.0	850.0	6
587	NF	03	HEVI	20.0	50.0	6	642	NF	03	BRDI	10.0	900.0	6
588	NF	03	SPCO	15.0	50.0	6	643	NF	03	SPCR	60.0	900.0	6
589	NF	03	SPCR	5.0	50.0	6	644	NF	03	BRDI	80.0	950.0	5
590	NF	03	AGAL	20.0	100.0	5	645	NF	03	CINE	3.0	950.0	5
591	NF	03	EQAR	3.0	100.0	5	646	NF	04	BRDI	40.0	20.0	6
592	NF	03	FEEL	15.0	100.0	5	647	NF	04	AGAL	5.0	50.0	6
593	NF	03	HEVI	10.0	100.0	5	648	NF	04	FEEL	35.0	50.0	6
594	NF	03	MEAL	3.0	100.0	5	649	NF	04	TYDO	10.0	50.0	6
595	NF	03	EQLA	5.0	120.0	6	650	NF	04	FEEL	60.0	100.0	6
596	NF	03	FEEL	40.0	120.0	6	651	NF	04	JUBA	40.0	100.0	6
597	NF	03	H2O	.	150.0	4	652	NF	04	AGAL	70.0	150.0	6
598	NF	03	H2O	.	200.0	6	653	NF	04	BRIN	5.0	150.0	6
599	NF	03	BRIN	35.0	270.0	6	654	NF	04	EUOC	2.0	150.0	6
600	NF	03	JUXI	1.0	290.0	6	655	NF	04	AGAL	35.0	200.0	6
601	NF	03	H2O	.	350.0	4	656	NF	04	JUBA	40.0	200.0	6
602	NF	03	H2O	.	400.0	3	657	NF	04	AGAL	10.0	250.0	6
603	NF	03	AGAL	30.0	450.0	6	658	NF	04	FEEL	10.0	250.0	6
604	NF	03	EQLA	25.0	450.0	6	659	NF	04	H2O	.	300.0	3
605	NF	03	FEEL	10.0	450.0	6	660	NF	04	H2O	.	350.0	6

Appendix C (Continued)
Raw Herb Cover Data Set

Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code	Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code
661	NF	04	ELEL	1.0	370.0	4	716	NF	05	SPCO	20.0	20.0	6
662	NF	04	FEEL	15.0	370.0	4	717	NF	05	BRDI	25.0	50.0	6
663	NF	04	TAOF	1.0	370.0	4	718	NF	05	ERDI	1.0	50.0	6
664	NF	04	AGAL	25.0	400.0	6	719	NF	05	HEVI	20.0	50.0	6
665	NF	04	FEEL	30.0	400.0	6	720	NF	05	SPCO	30.0	50.0	6
666	NF	04	MEIN	2.0	400.0	6	721	NF	05	BRDI	99.0	100.0	6
667	NF	04	POPR	5.0	400.0	6	722	NF	05	BRDI	90.0	150.0	6
668	NF	04	AGAL	15.0	420.0	6	723	NF	05	CALA	10.0	200.0	7
669	NF	04	EQLA	3.0	420.0	6	724	NF	05	EQLA	1.0	200.0	7
670	NF	04	FEEL	15.0	420.0	6	725	NF	05	FEEL	20.0	200.0	7
671	NF	04	MEAL	5.0	420.0	6	726	NF	05	H2O	.	300.0	4
672	NF	04	H2O	.	440.0	4	727	NF	05	H2O	.	350.0	3
673	NF	04	H2O	.	460.0	6	728	NF	05	H2O	.	400.0	3
674	NF	04	AGAL	10.0	480.0	4	729	NF	05	H2O	.	450.0	4
675	NF	04	ARLU	2.0	480.0	4	730	NF	05	H2O	.	500.0	6
676	NF	04	EQLA	5.0	480.0	4	731	NF	05	AGAL	25.0	540.0	6
677	NF	04	HEVI	4.0	480.0	4	732	NF	05	EQLA	5.0	540.0	6
678	NF	04	MEAL	3.0	480.0	4	733	NF	05	AGAL	25.0	580.0	5
679	NF	04	MEIN	2.0	480.0	4	734	NF	05	HEVI	5.0	580.0	5
680	NF	04	SOAS	1.0	480.0	4	735	NF	05	HEVI	15.0	600.0	6
681	NF	04	TAOF	1.0	480.0	4	736	NF	05	OELO	10.0	600.0	6
682	NF	04	HEVI	10.0	500.0	4	737	NF	05	SPCR	1.0	600.0	6
683	NF	04	LEPU	8.0	500.0	4	738	NF	05	HEVI	35.0	650.0	6
684	NF	04	PEPA	4.0	500.0	4	739	NF	05	SPCR	10.0	650.0	6
685	NF	04	AGAL	15.0	550.0	6	740	NF	05	HEVI	40.0	700.0	6
686	NF	04	BRDI	20.0	550.0	6	741	NF	05	SPCR	5.0	700.0	6
687	NF	04	ERDI	1.0	550.0	6	742	NF	05	HEVI	15.0	750.0	6
688	NF	04	HEVI	40.0	550.0	6	743	NF	05	SPCR	10.0	750.0	6
689	NF	04	AGAL	35.0	600.0	6	744	NF	05	HEVI	20.0	800.0	6
690	NF	04	COCA	1.0	600.0	6	745	NF	05	SPCR	10.0	800.0	6
691	NF	04	EQLA	15.0	600.0	6	746	NF	05	BRDI	5.0	850.0	6
692	NF	04	FEEL	10.0	600.0	6	747	NF	05	HEVI	25.0	850.0	6
693	NF	04	BRIN	99.0	650.0	6	748	NF	05	SPCR	3.0	850.0	6
694	NF	04	HEVI	15.0	700.0	6	749	NF	05	BRDI	99.0	900.0	6
695	NF	04	SPCR	15.0	700.0	6	750	NF	05	BRDI	90.0	950.0	6
696	NF	04	VETH	2.0	700.0	6	751	NF	05	SPCR	5.0	950.0	6
697	NF	04	ARLO	3.0	750.0	6	752	NF	05	BRDI	15.0	1000.0	6
698	NF	04	ERDI	1.0	750.0	6	753	NF	05	SPCO	35.0	1000.0	6
699	NF	04	HEVI	4.0	750.0	6	754	NF	05	BRDI	99.0	1050.0	6
700	NF	04	MEIN	1.0	750.0	6	755	NF	06	HEVI	35.0	10.0	6
701	NF	04	POGL	1.0	750.0	6	756	NF	06	SESP	5.0	10.0	6
702	NF	04	AGAL	60.0	800.0	6	757	NF	06	SPCO	10.0	10.0	6
703	NF	04	EUOC	1.0	800.0	6	758	NF	06	BRDI	10.0	50.0	2
704	NF	04	MUAS	10.0	800.0	6	759	NF	06	HEVI	10.0	50.0	2
705	NF	04	OELO	1.0	800.0	6	760	NF	06	POGL	5.0	50.0	2
706	NF	04	POCO	10.0	800.0	6	761	NF	06	SPCO	5.0	50.0	2
707	NF	04	BRDI	20.0	850.0	6	762	NF	06	AGAL	15.0	120.0	6
708	NF	04	HEVI	15.0	850.0	6	763	NF	06	FEEL	30.0	120.0	6
709	NF	04	VETH	35.0	850.0	6	764	NF	06	MEAL	3.0	120.0	6
710	NF	04	BRDI	5.0	900.0	6	765	NF	06	MEIN	5.0	120.0	6
711	NF	04	HEVI	30.0	900.0	6	766	NF	06	AGAL	15.0	150.0	5
712	NF	04	SPCR	45.0	900.0	6	767	NF	06	FEEL	10.0	150.0	5
713	NF	04	BRDI	99.0	950.0	6	768	NF	06	MEAL	1.0	150.0	5
714	NF	05	BRDI	55.0	20.0	6	769	NF	06	H2O	.	200.0	3
715	NF	05	HEVI	15.0	20.0	6	770	NF	06	H2O	.	250.0	3

Appendix C (Continued)
Raw Herb Cover Data Set

Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code	Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code
771	NF	06	H2O	.	300.0	4	826	NF	07	POPR	15.0	550.0	6
772	NF	06	AGAL	20.0	320.0	3	827	NF	07	SESP	10.0	550.0	6
773	NF	06	EQAR	5.0	320.0	3	828	NF	07	SPCR	20.0	550.0	6
774	NF	06	JUBA	1.0	320.0	3	829	NF	07	HEVI	50.0	600.0	6
775	NF	06	MEAL	3.0	320.0	3	830	NF	07	SPCR	30.0	600.0	6
776	NF	06	SCMI	25.0	320.0	3	831	NF	07	AGAL	20.0	650.0	6
777	NF	06	AGAL	60.0	350.0	6	832	NF	07	BRDI	10.0	650.0	6
778	NF	06	FEEL	15.0	350.0	6	833	NF	07	DAIN	1.0	650.0	6
779	NF	06	MUAN	15.0	350.0	6	834	NF	07	POPR	35.0	650.0	6
780	NF	06	AGAL	30.0	400.0	6	835	NF	07	AGAL	70.0	700.0	6
781	NF	06	AGTR	10.0	400.0	6	836	NF	07	AGAL	70.0	750.0	6
782	NF	06	BRTE	10.0	400.0	6	837	NF	07	FEEL	10.0	750.0	6
783	NF	06	HEVI	10.0	450.0	4	838	NF	07	AGAL	15.0	800.0	6
784	NF	06	SCSC	10.0	450.0	4	839	NF	07	AGAL	60.0	850.0	6
785	NF	06	SESP	5.0	450.0	4	840	NF	07	FEEL	20.0	850.0	6
786	NF	06	HEVI	25.0	500.0	6	841	NF	07	H2O	.	900.0	3
787	NF	06	POGL	3.0	500.0	6	842	NF	07	H2O	.	950.0	3
788	NF	06	SCSC	10.0	500.0	6	843	NF	07	H2O	.	1000.0	3
789	NF	06	GUSA	1.0	550.0	4	844	NF	07	H2O	.	1050.0	3
790	NF	06	HEVI	15.0	550.0	4	845	NF	07	H2O	.	1150.0	4
791	NF	06	SCSC	10.0	550.0	4	846	NF	07	AGAL	10.0	1170.0	4
792	NF	06	SPCR	10.0	550.0	4	847	NF	07	FEEL	70.0	1170.0	4
793	NF	06	BRTE	40.0	600.0	6	848	NF	08	BRDI	20.0	20.0	6
794	NF	06	SOAS	2.0	600.0	6	849	NF	08	BRTE	70.0	20.0	6
795	NF	06	AGAL	45.0	650.0	6	850	NF	08	DAWR	15.0	20.0	6
796	NF	06	SCSC	2.0	650.0	6	851	NF	08	BRDI	60.0	40.0	6
797	NF	06	AGAL	10.0	700.0	5	852	NF	08	BRTE	25.0	40.0	6
798	NF	06	AGTR	60.0	700.0	5	853	NF	08	BRDI	75.0	80.0	6
799	NF	06	BRDI	15.0	750.0	6	854	NF	08	BRDI	80.0	120.0	6
800	NF	06	HEVI	10.0	750.0	6	855	NF	08	BRDI	90.0	160.0	6
801	NF	06	SPCR	30.0	750.0	6	856	NF	08	BRDI	90.0	200.0	6
802	NF	06	BRDI	90.0	800.0	6	857	NF	08	EQLA	5.0	200.0	6
803	NF	06	ELEL	2.0	800.0	6	858	NF	08	BRDI	90.0	250.0	6
804	NF	06	BRDI	99.0	850.0	6	859	NF	08	EQLA	9.0	250.0	6
805	NF	06	BRDI	99.0	900.0	6	860	NF	08	BRDI	90.0	300.0	6
806	NF	06	BRDI	60.0	950.0	7	861	NF	08	EQLA	2.0	300.0	6
807	NF	07	BRDI	90.0	100.0	6	862	NF	08	BRDI	15.0	350.0	6
808	NF	07	BRDI	90.0	150.0	6	863	NF	08	EQLA	3.0	350.0	6
809	NF	07	DAWR	2.0	150.0	6	864	NF	08	SPCO	25.0	350.0	6
810	NF	07	BRDI	10.0	200.0	6	865	NF	08	BRDI	40.0	400.0	6
811	NF	07	HEVI	35.0	200.0	6	866	NF	08	EQLA	10.0	400.0	6
812	NF	07	SPCR	25.0	200.0	6	867	NF	08	BRDI	50.0	450.0	6
813	NF	07	BRDI	90.0	250.0	6	868	NF	08	EQLA	20.0	450.0	6
814	NF	07	BRDI	10.0	350.0	6	869	NF	08	BRDI	50.0	500.0	6
815	NF	07	POGL	10.0	350.0	6	870	NF	08	SESP	10.0	500.0	6
816	NF	07	POPR	75.0	350.0	6	871	NF	08	BRDI	25.0	550.0	6
817	NF	07	HEVI	20.0	400.0	6	872	NF	08	HEVI	35.0	550.0	6
818	NF	07	POPR	50.0	400.0	6	873	NF	08	EQLA	2.0	600.0	6
819	NF	07	BRDI	10.0	450.0	6	874	NF	08	HEVI	60.0	600.0	6
820	NF	07	HEVI	15.0	450.0	6	875	NF	08	MOSS	4.0	600.0	6
821	NF	07	POPR	25.0	450.0	6	876	NF	08	SESP	1.0	600.0	6
822	NF	07	SPCR	20.0	450.0	6	877	NF	08	EQLA	10.0	650.0	6
823	NF	07	BRDI	15.0	500.0	6	878	NF	08	HEVI	60.0	650.0	6
824	NF	07	POPR	55.0	500.0	6	879	NF	08	MOSS	10.0	650.0	6
825	NF	07	HEVI	15.0	550.0	6	880	NF	08	SPCR	10.0	650.0	6

Appendix C (Continued)
Raw Herb Cover Data Set

Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code	Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code
881	NF	08	VETH	1.0	650.0	6	936	NF	09	BRDI	45.0	300.0	6
882	NF	08	EQLA	10.0	700.0	6	937	NF	09	EQLA	10.0	300.0	6
883	NF	08	HEVI	70.0	700.0	6	938	NF	09	POGL	10.0	300.0	6
884	NF	08	MOSS	15.0	700.0	6	939	NF	09	POPR	15.0	300.0	6
885	NF	08	SPCR	5.0	700.0	6	940	NF	09	BRDI	15.0	400.0	6
886	NF	08	VETH	15.0	700.0	6	941	NF	09	EQLA	5.0	400.0	6
887	NF	08	BRDI	75.0	750.0	6	942	NF	09	MUAS	65.0	400.0	6
888	NF	08	EQLA	5.0	750.0	6	943	NF	09	BRDI	10.0	500.0	6
889	NF	08	HEVI	5.0	750.0	6	944	NF	09	EQLA	20.0	500.0	6
890	NF	08	MOSS	15.0	750.0	6	945	NF	09	HEVI	70.0	500.0	6
891	NF	08	SESP	10.0	750.0	6	946	NF	09	BRDI	5.0	600.0	6
892	NF	08	BRDI	90.0	800.0	6	947	NF	09	EQLA	2.0	600.0	6
893	NF	08	EQLA	5.0	800.0	6	948	NF	09	HEVI	45.0	600.0	6
894	NF	08	BRDI	25.0	850.0	6	949	NF	09	SESP	5.0	600.0	6
895	NF	08	EQLA	10.0	850.0	6	950	NF	09	EQLA	5.0	700.0	6
896	NF	08	HEVI	4.0	850.0	6	951	NF	09	HEVI	45.0	700.0	6
897	NF	08	MOSS	5.0	850.0	6	952	NF	09	MOSS	10.0	700.0	6
898	NF	08	SPCO	15.0	850.0	6	953	NF	09	SPCR	3.0	700.0	6
899	NF	08	BRDI	15.0	900.0	6	954	NF	09	BRDI	45.0	800.0	6
900	NF	08	EQLA	5.0	900.0	6	955	NF	09	EQLA	20.0	800.0	6
901	NF	08	HEVI	30.0	900.0	6	956	NF	09	PHHE4	4.0	800.0	6
902	NF	08	MOSS	5.0	900.0	6	957	NF	09	SESP	3.0	800.0	6
903	NF	08	SPCO	10.0	900.0	6	958	NF	09	HEVI	25.0	900.0	6
904	NF	08	BRDI	15.0	950.0	6	959	NF	09	MOSS	45.0	900.0	6
905	NF	08	HEVI	15.0	950.0	6	960	NF	09	SPCR	10.0	900.0	6
906	NF	08	SPCO	35.0	950.0	6	961	NF	09	HEVI	30.0	1000.0	6
907	NF	08	BRDI	5.0	1000.0	6	962	NF	09	MACA	3.0	1000.0	6
908	NF	08	HEVI	15.0	1000.0	6	963	NF	09	MOSS	20.0	1000.0	6
909	NF	08	MOSS	4.0	1000.0	6	964	NF	09	POGL	3.0	1000.0	6
910	NF	08	SPCO	65.0	1000.0	6	965	NF	09	SESP	20.0	1000.0	6
911	NF	08	EQLA	1.0	1050.0	6	966	NF	09	SPCO	10.0	1000.0	6
912	NF	08	HEVI	40.0	1050.0	6	967	NF	09	BRDI	70.0	1100.0	6
913	NF	08	MOSS	15.0	1050.0	6	968	NF	09	SESP	30.0	1100.0	6
914	NF	08	POGL	3.0	1050.0	6	969	NF	09	HEVI	50.0	1200.0	6
915	NF	08	BRDI	45.0	1100.0	6	970	NF	09	MOSS	25.0	1200.0	6
916	NF	08	HEVI	10.0	1100.0	6	971	NF	09	SESP	15.0	1200.0	6
917	NF	08	MOSS	10.0	1100.0	6	972	NF	09	HEVI	20.0	1300.0	6
918	NF	08	POGL	5.0	1100.0	6	973	NF	09	MOSS	5.0	1300.0	6
919	NF	08	AGTR	55.0	1150.0	6	974	NF	09	SPFL	10.0	1300.0	6
920	NF	08	HEVI	15.0	1150.0	6	975	NF	09	BRDI	55.0	1400.0	6
921	NF	08	AGTR	40.0	1200.0	6	976	NF	09	HEVI	15.0	1400.0	6
922	NF	08	DAWR	2.0	1200.0	6	977	NF	09	SESP	10.0	1400.0	6
923	NF	08	EQLA	5.0	1200.0	6	978	NF	09	MUAS	99.0	1430.0	6
924	NF	08	AGTR	5.0	1250.0	6	979	NF	09	FEEL	40.0	1440.0	6
925	NF	08	BRDI	3.0	1250.0	6	980	NF	09	MUAS	45.0	1440.0	6
926	NF	08	EQLA	10.0	1250.0	6	981	NF	09	H2O	.	1470.0	3
927	NF	08	MUAS	25.0	1250.0	6	982	NF	09	H2O	.	1500.0	3
928	NF	08	PHHE4	1.0	1250.0	6	983	NF	09	AGAL	5.0	1560.0	6
929	NF	08	SPCR	5.0	1250.0	6	984	NF	09	EQAR	1.0	1560.0	6
930	NF	08	FEEL	35.0	1280.0	6	985	NF	09	EQLA	30.0	1560.0	6
931	NF	08	JUBA	15.0	1280.0	6	986	NF	09	JUEFB	15.0	1560.0	6
932	NF	09	BRDI	90.0	20.0	4	987	NF	09	RACYS	2.0	1560.0	6
933	NF	09	BRDI	90.0	50.0	6	988	NF	09	AGAL	5.0	1590.0	6
934	NF	09	BRDI	85.0	100.0	6	989	NF	09	ARLU	1.0	1590.0	6
935	NF	09	BRDI	90.0	200.0	6	990	NF	09	COCA	1.0	1590.0	6

Appendix C (Continued)
Raw Herb Cover Data Set

Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code	Record No.	Stream	Transect	Species	Percent Cover	Quadrat Location	Substrate Code
991	NF	09	FEEL	5.0	1590.0	6	1037	NF	10	SESP	10.0	350.0	6
992	NF	09	JUEFB	20.0	1590.0	6	1038	NF	10	SPFL	5.0	350.0	6
993	NF	09	MEAL	1.0	1590.0	6	1039	NF	10	BRTE	10.0	450.0	6
994	NF	09	MEAR	2.0	1590.0	6	1040	NF	10	HEVI	55.0	450.0	6
995	NF	09	MUAD	5.0	1590.0	6	1041	NF	10	SESP	30.0	450.0	6
996	NF	09	RACYS	3.0	1590.0	6	1042	NF	10	BRDI	3.0	550.0	6
997	NF	09	TAOF	1.0	1590.0	6	1043	NF	10	BRTE	10.0	550.0	6
998	NF	09	AGAL	10.0	1620.0	6	1044	NF	10	HEVI	60.0	550.0	6
999	NF	09	ASAS	5.0	1620.0	6	1045	NF	10	HEVI	35.0	650.0	6
1000	NF	09	COCA	2.0	1620.0	6	1046	NF	10	MOSS	15.0	650.0	6
1001	NF	09	EPCI	1.0	1620.0	6	1047	NF	10	POGL	15.0	650.0	6
1002	NF	09	EPGI	2.0	1620.0	6	1048	NF	10	BRDI	15.0	750.0	6
1003	NF	09	EQAR	5.0	1620.0	6	1049	NF	10	HEVI	35.0	750.0	6
1004	NF	09	EQLA	20.0	1620.0	6	1050	NF	10	MOSS	30.0	750.0	6
1005	NF	09	JUEFB	25.0	1620.0	6	1051	NF	10	SESP	15.0	750.0	6
1006	NF	09	MEAR	1.0	1620.0	6	1052	NF	10	BRDI	20.0	850.0	6
1007	NF	09	RACYS	5.0	1620.0	6	1053	NF	10	HEVI	20.0	850.0	6
1008	NF	09	VEBR	10.0	1620.0	6	1054	NF	10	SESP	30.0	850.0	6
1009	NF	09	AGAL	10.0	1650.0	6	1055	NF	10	BRDI	50.0	950.0	6
1010	NF	09	ARLU	1.0	1650.0	6	1056	NF	10	HEVI	20.0	950.0	6
1011	NF	09	EQLA	40.0	1650.0	6	1057	NF	10	HEVI	30.0	1050.0	6
1012	NF	09	FEEL	10.0	1650.0	6	1058	NF	10	MOSS	40.0	1050.0	6
1013	NF	09	JUEFB	25.0	1650.0	6	1059	NF	10	SPFL	15.0	1050.0	6
1014	NF	09	TRRE	3.0	1650.0	6	1060	NF	10	HEVI	40.0	1150.0	6
1015	NF	09	AGAL	15.0	1680.0	6	1061	NF	10	MOSS	30.0	1150.0	6
1016	NF	09	EQAR	15.0	1680.0	6	1062	NF	10	SPCO	25.0	1150.0	6
1017	NF	09	AGAL	5.0	1710.0	6	1063	NF	10	ABFR	1.0	1250.0	6
1018	NF	09	EQAR	1.0	1710.0	6	1064	NF	10	HEVI	50.0	1250.0	6
1019	NF	09	EQAR	80.0	1710.0	6	1065	NF	10	SPCO	3.0	1250.0	6
1020	NF	09	TAOF	1.0	1710.0	6	1066	NF	10	EQLA	10.0	1340.0	6
1021	NF	09	EQLA	75.0	1730.0	6	1067	NF	10	MUAS	15.0	1340.0	6
1022	NF	09	EQTE	3.0	1730.0	6	1068	NF	10	AGTR	35.0	1350.0	6
1023	NF	09	EUOC	2.0	1730.0	6	1069	NF	10	HEVI	15.0	1350.0	6
1024	NF	09	TYLA	10.0	1730.0	6	1070	NF	10	EQLA	3.0	1360.0	4
1025	NF	09	H2O	.	1760.0	6	1071	NF	10	MUAS	5.0	1360.0	4
1026	NF	09	AGAL	5.0	1780.0	6	1072	NF	10	H2O	.	1400.0	4
1027	NF	09	FEEL	65.0	1780.0	6	1073	NF	10	H2O	.	1450.0	4
1028	NF	10	SPFL	85.0	50.0	6	1074	NF	10	H2O	.	1500.0	4
1029	NF	10	BRRU	5.0	150.0	6	1075	NF	10	H2O	.	1550.0	4
1030	NF	10	HEVI	15.0	150.0	6	1076	NF	10	H2O	.	1600.0	4
1031	NF	10	POPR	10.0	150.0	6	1077	NF	10	H2O	.	1650.0	4
1032	NF	10	SPFL	10.0	150.0	6	1078	NF	10	H2O	.	1700.0	4
1033	NF	10	VETH	10.0	150.0	6	1079	NF	10	FEEL	30.0	1710.0	6
1034	NF	10	BRTE	2.0	250.0	6	1080	NF	10	TYLA	10.0	1710.0	6
1035	NF	10	HEVI	65.0	250.0	6	1081	NF	10	FEEL	60.0	1730.0	6
1036	NF	10	HEVI	60.0	350.0	6	1082	NF	10	BRDI	5.0	1750.0	6
							1083	NF	10	HEVI	20.0	1750.0	6

APPENDIX D

Raw Line-intercept Data Set

Appendix D
Raw Line-intercept Data Set

Record No.	Stream	Transect	Species	Substrate Code	Intercept (dm) Begin	End	Record No.	Stream	Transect	Species	Substrate Code	Intercept (dm) Begin	End
1	EF	01	ATCA	6	861.0	876.0	56	EF	03	POFR	6	963.0	975.0
2	EF	01	ATCA	6	889.0	899.0	57	EF	03	PSFR	6	631.0	643.0
3	EF	01	ATCA	6	934.0	943.0	58	EF	03	SAME	6	835.0	840.0
4	EF	01	ATCA	6	1010.0	1024.0	59	EF	03	SAME	6	855.0	874.0
5	EF	01	BAEM	6	103.0	137.0	60	EF	03	SAME	6	948.0	962.0
6	EF	01	BAEM	6	416.0	461.0	61	EF	04	ARFI	6	341.0	354.0
7	EF	01	CHNA	6	8.0	17.0	62	EF	04	ARFI	6	416.0	430.0
8	EF	01	CHNA	6	94.0	97.0	63	EF	04	BAEM	6	910.0	923.0
9	EF	01	CHNA	6	360.0	365.0	64	EF	04	CHNA	6	65.0	89.0
10	EF	01	CHNA	6	377.0	390.0	65	EF	04	CHNA	6	170.0	195.0
11	EF	01	CHNA	6	580.0	585.0	66	EF	04	CHNA	6	273.0	280.0
12	EF	01	CHNA	6	648.0	655.0	67	EF	04	CHNA	6	403.0	410.0
13	EF	01	CHNA	5	722.0	729.0	68	EF	04	CHNA	6	557.0	561.0
14	EF	01	CHNA	6	792.0	800.0	69	EF	04	CHNA	5	596.0	599.0
15	EF	01	CHNA	6	950.0	983.0	70	EF	04	CHNA	6	643.0	648.0
16	EF	01	JUOS	6	1025.0	1045.0	71	EF	04	CHNA	6	665.0	677.0
17	EF	01	OPPH	5	753.0	769.0	72	EF	04	CHNA	6	772.0	782.0
18	EF	01	POFR	6	76.0	90.0	73	EF	04	CHNA	6	835.0	840.0
19	EF	01	POFR	6	438.0	493.0	74	EF	04	CHNA	6	1202.0	1213.0
20	EF	01	POFR	6	512.0	515.0	75	EF	04	GUSA	4	1250.0	1255.0
21	EF	01	POFR	6	670.0	685.0	76	EF	04	OPPH	5	1270.0	1280.0
22	EF	01	POFR	6	1020.0	1103.0	77	EF	04	POFR	6	463.0	543.0
23	EF	01	PUTR	6	68.0	76.0	78	EF	04	POFR	6	620.0	627.0
24	EF	01	SAME	6	135.0	175.0	79	EF	04	POFR	6	899.0	920.0
25	EF	01	SAME	6	288.0	312.0	80	EF	04	PUTR	6	831.0	847.0
26	EF	02	BAEM	5	230.0	242.0	81	EF	04	RHTR	6	835.0	858.0
27	EF	02	BAEM	6	379.0	383.0	82	EF	04	SAME	6	990.0	997.0
28	EF	02	BAEM	6	395.0	415.0	83	EF	05	ARFI	6	408.0	412.0
29	EF	02	BAEM	6	473.0	479.0	84	EF	05	ARFI	6	1093.0	1130.0
30	EF	02	CHNA	6	180.0	189.0	85	EF	05	ARTR	6	250.0	259.0
31	EF	02	CHNA	6	484.0	495.0	86	EF	05	ARTR	6	1300.0	1309.0
32	EF	02	CHNA	6	512.0	518.0	87	EF	05	BAEM	6	602.0	640.0
33	EF	02	CHNA	6	570.0	577.0	88	EF	05	BAEM	6	840.0	848.0
34	EF	02	CHNA	6	912.0	925.0	89	EF	05	BAEM	6	877.0	897.0
35	EF	02	CHNA	6	1091.0	1150.0	90	EF	05	CHNA	6	163.0	170.0
36	EF	02	CHNA	6	1170.0	1183.0	91	EF	05	CHNA	6	265.0	270.0
37	EF	02	CHNA	0	1205.0	1217.0	92	EF	05	CHNA	6	379.0	384.0
38	EF	02	ELAN	6	419.0	439.0	93	EF	05	CHNA	6	521.0	536.0
39	EF	02	POFR	3	210.0	242.0	94	EF	05	CHNA	6	1026.0	1040.0
40	EF	02	POFR	0	437.0	462.0	95	EF	05	CHNA	6	1310.0	1320.0
41	EF	02	POFR	6	630.0	690.0	96	EF	05	CHNA	6	1480.0	1497.0
42	EF	02	POFR	6	760.0	770.0	97	EF	05	CHNA	6	1580.0	1600.0
43	EF	02	SAME	6	238.0	242.0	98	EF	05	GUSA	6	180.0	184.0
44	EF	02	SAME	6	348.0	357.0	99	EF	05	GUSA	6	190.0	199.0
45	EF	02	SAME	6	401.0	409.0	100	EF	05	GUSA	6	260.0	265.0
46	EF	03	ARFI	6	553.0	575.0	101	EF	05	GUSA	6	290.0	295.0
47	EF	03	BAEM	6	686.0	710.0	102	EF	05	JUOS	6	911.0	970.0
48	EF	03	BAEM	6	897.0	914.0	103	EF	05	POFR	6	197.0	216.0
49	EF	03	BAEM	6	970.0	978.0	104	EF	05	POFR	6	592.0	687.0
50	EF	03	CHNA	6	295.0	304.0	105	EF	05	POFR	6	867.0	930.0
51	EF	03	CHNA	6	403.0	408.0	106	EF	05	POFR	6	1250.0	1290.0
52	EF	03	CHNA	6	591.0	595.0	107	EF	05	PSFR	6	310.0	318.0
53	EF	03	CHNA	6	628.0	633.0	108	EF	05	PSFR	6	334.0	349.0
54	EF	03	POFR	6	587.0	710.0	109	EF	05	PSFR	6	505.0	518.0
55	EF	03	POFR	6	878.0	885.0	110	EF	05	PSFR	6	1072.0	1084.0

Appendix D (Continued)
Raw Line-intercept Data Set

Record No.	Stream	Transect	Species	Substrate Code	Intercept (dm) Begin	End	Record No.	Stream	Transect	Species	Substrate Code	Intercept (dm) Begin	End
111	EF	05	PSFR	6	1372.0	1480.0	166	NF	01	TARA	6	222.0	227.0
112	EF	06	ATCA	6	0.0	21.0	167	NF	01	TARA	6	613.0	616.0
113	EF	06	BAEM	6	153.0	195.0	168	NF	01	TARA	6	641.0	649.0
114	EF	06	BAEM	6	250.0	280.0	169	NF	01	TARA	6	649.0	669.0
115	EF	06	BAEM	6	408.0	420.0	170	NF	02	ACNE	2	1175.0	1197.0
116	EF	06	CHNA	6	0.0	56.0	171	NF	02	BAEM	6	324.0	330.0
117	EF	06	CHNA	6	600.0	614.0	172	NF	02	BAEM	4	335.0	337.0
118	EF	06	CHNA	6	900.0	910.0	173	NF	02	BAEM	5	370.0	374.0
119	EF	06	CHNA	6	1014.0	1074.0	174	NF	02	BAEM	6	414.0	416.0
120	EF	06	GUSA	6	1200.0	1221.0	175	NF	02	BAEM	6	476.0	488.0
121	EF	06	POFR	6	485.0	527.0	176	NF	02	BAEM	6	503.0	515.0
122	EF	06	POFR	6	593.0	625.0	177	NF	02	BAEM	0	521.0	524.0
123	EF	06	SAME	6	210.0	290.0	178	NF	02	BAEM	0	548.0	551.0
124	EF	07	ARFI	6	1195.0	1230.0	179	NF	02	BAEM	6	609.0	620.0
125	EF	07	BAEM	6	510.0	527.0	180	NF	02	BAEM	6	629.0	640.0
126	EF	07	BAEM	6	577.0	588.0	181	NF	02	BAEM	6	648.0	667.0
127	EF	07	CHNA	6	0.0	43.0	182	NF	02	BAEM	6	694.0	699.0
128	EF	07	CHNA	6	54.0	65.0	183	NF	02	BAEM	3	794.0	799.0
129	EF	07	CHNA	6	75.0	97.0	184	NF	02	BAEM	6	807.0	816.0
130	EF	07	CHNA	6	637.0	644.0	185	NF	02	FRVE	3	841.0	842.0
131	EF	07	CHNA	6	880.0	889.0	186	NF	02	FRVE	6	1093.0	1175.0
132	EF	07	CHNA	0	1000.0	1010.0	187	NF	02	POFR	6	330.0	331.0
133	EF	07	CHNA	0	1100.0	1125.0	188	NF	02	POFR	6	392.0	395.0
134	EF	07	CHNA	0	1240.0	1259.0	189	NF	02	POFR	5	527.0	528.0
135	EF	07	FRAN	6	934.0	960.0	190	NF	02	POFR	7	539.0	540.0
136	EF	07	GUSA	6	135.0	145.0	191	NF	02	POFR	6	680.0	683.0
137	EF	07	JUOS	6	110.0	118.0	192	NF	02	SAME	4	378.0	379.0
138	EF	07	LYAN	6	860.0	872.0	193	NF	02	TARA	5	378.0	382.0
139	EF	07	POFR	6	598.0	630.0	194	NF	02	TARA	6	465.0	466.0
140	EF	07	SAGO	6	97.0	116.0	195	NF	02	TARA	6	673.0	675.0
141	EF	07	SAME	6	393.0	410.0	196	NF	02	TARA	6	953.0	1250.0
142	EF	07	SAME	6	456.0	464.0	197	NF	03	ACNE	2	0.0	12.0
143	EF	07	YUAN	6	659.0	682.0	198	NF	03	ACNE	2	944.0	995.0
144	EF	08	ARFI	6	670.0	682.0	199	NF	03	BAEM	5	103.0	124.0
145	EF	08	ARFI	6	715.0	739.0	200	NF	03	BAEM	4	510.0	519.0
146	EF	08	BAEM	6	310.0	350.0	201	NF	03	BAGL	6	444.0	447.0
147	EF	08	BAEM	6	460.0	471.0	202	NF	03	BAGL	6	576.0	585.0
148	EF	08	BAEM	6	559.0	618.0	203	NF	03	BAGL	6	592.0	599.0
149	EF	08	CHNA	6	105.0	117.0	204	NF	03	BAGL	4	660.0	664.0
150	EF	08	CHNA	6	650.0	670.0	205	NF	03	BAGL	6	723.0	763.0
151	EF	08	JUOS	6	218.0	234.0	206	NF	03	CERE	2	0.0	9.0
152	EF	08	PLSE	6	310.0	350.0	207	NF	03	OPPH	6	20.0	22.0
153	EF	08	POFR	6	284.0	310.0	208	NF	03	POFR	3	899.0	995.0
154	EF	08	POFR	6	590.0	685.0	209	NF	03	TARA	6	112.0	131.0
155	EF	08	SAME	6	440.0	463.0	210	NF	03	TARA	4	486.0	488.0
156	EF	08	SAME	6	469.0	474.0	211	NF	03	TARA	0	592.0	593.0
157	NF	01	ACNE	6	499.0	541.0	212	NF	03	VIAR	2	0.0	3.0
158	NF	01	ACNE	6	620.0	634.0	213	NF	04	ACNE	6	915.0	997.0
159	NF	01	ACNE	6	1146.0	1190.0	214	NF	04	BAEM	6	42.0	55.0
160	NF	01	AMUT	2	1119.0	1120.0	215	NF	04	BAEM	6	134.0	160.0
161	NF	01	BAEM	6	278.0	282.0	216	NF	04	BAEM	6	170.0	230.0
162	NF	01	BAEM	6	544.0	599.0	217	NF	04	BAEM	6	249.0	256.0
163	NF	01	BAEM	6	754.0	889.0	218	NF	04	BAEM	4	386.0	392.0
164	NF	01	BAEM	6	1060.0	1065.0	219	NF	04	BAEM	4	475.0	485.0
165	NF	01	POFR	6	5.0	140.0	220	NF	04	BAEM	6	613.0	621.0

Appendix D (Continued)
Raw Line-intercept Data Set

Record No.	Stream	Transect	Species	Substrate Code	Intercept (dm) Begin	End	Record No.	Stream	Transect	Species	Substrate Code	Intercept (dm) Begin	End
221	NF	04	BAEM	6	638.0	668.0	268	NF	07	POFR	6	290.0	320.0
222	NF	04	FRVE	6	0.0	49.0	269	NF	07	POFR	6	467.0	570.0
223	NF	04	FRVE	6	626.0	628.0	270	NF	07	POFR	6	646.0	797.0
224	NF	04	POFR	6	160.0	173.0	271	NF	07	POFR	6	810.0	860.0
225	NF	04	POFR	6	909.0	960.0	272	NF	07	QUTU	6	24.0	25.0
226	NF	04	TARA	6	93.0	117.0	273	NF	07	TARA	6	760.0	764.0
227	NF	04	TARA	6	135.0	139.0	274	NF	07	VIAR	7	290.0	320.0
228	NF	04	TARA	6	220.0	249.0	275	NF	07	VIAR	3	1200.0	1230.0
229	NF	04	TARA	6	265.0	281.0	276	NF	08	ACNE	6	0.0	127.0
230	NF	04	TARA	6	663.0	670.0	277	NF	08	ACNE	6	186.0	223.0
231	NF	05	ACNE	6	117.0	175.0	278	NF	08	ACNE	6	258.0	344.0
232	NF	05	ACNE	6	867.0	948.0	279	NF	08	ACNE	6	358.0	391.0
233	NF	05	ACNE	6	1024.0	1080.0	280	NF	08	ACNE	6	498.0	583.0
234	NF	05	BAEM	6	167.0	262.0	281	NF	08	ACNE	6	756.0	814.0
235	NF	05	BAEM	6	561.0	569.0	282	NF	08	ACNE	6	1165.0	1217.0
236	NF	05	BAEM	5	580.0	593.0	283	NF	08	BAEM	6	1285.0	1300.0
237	NF	05	CERE	6	10.0	18.0	284	NF	08	FRVE	6	130.0	287.0
238	NF	05	POFR	6	1024.0	1080.0	285	NF	08	FRVE	6	951.0	976.0
239	NF	05	SAGO	6	54.0	140.0	286	NF	08	FRVE	6	1124.0	1161.0
240	NF	05	TARA	6	167.0	171.0	287	NF	08	FRVE	6	1231.0	1280.0
241	NF	06	ACNE	6	0.0	14.0	288	NF	08	POFR	3	1590.0	1693.0
242	NF	06	ACNE	6	827.0	903.0	289	NF	08	TARA	6	1295.0	1300.0
243	NF	06	ACNE	6	980.0	1000.0	290	NF	09	ACNE	4	0.0	65.0
244	NF	06	BAEM	6	80.0	95.0	291	NF	09	ACNE	6	180.0	321.0
245	NF	06	BAGL	4	90.0	95.0	292	NF	09	ACNE	6	435.0	486.0
246	NF	06	BAGL	6	334.0	460.0	293	NF	09	ACNE	6	602.0	631.0
247	NF	06	BAGL	6	620.0	650.0	294	NF	09	ACNE	7	1050.0	1167.0
248	NF	06	FRVE	4	460.0	470.0	295	NF	09	ACNE	6	1380.0	1430.0
249	NF	06	FRVE	6	729.0	814.0	296	NF	09	ACNE	6	1790.0	1834.0
250	NF	06	HASC	4	463.0	468.0	297	NF	09	BAEM	6	1437.0	1452.0
251	NF	06	OPPH	6	50.0	57.0	298	NF	09	BAGL	6	1626.0	1630.0
252	NF	06	TARA	4	110.0	120.0	299	NF	09	CLLI	6	1625.0	1628.0
253	NF	06	TARA	6	325.0	327.0	300	NF	09	FRVE	6	330.0	387.0
254	NF	06	TARA	6	584.0	669.0	301	NF	09	FRVE	6	697.0	820.0
255	NF	06	TARA	6	678.0	700.0	302	NF	09	FRVE	6	1784.0	1788.0
256	NF	07	ACNE	2	70.0	128.0	303	NF	09	TARA	6	1752.0	1787.0
257	NF	07	ACNE	6	290.0	309.0	304	NF	10	ACNE	6	494.0	520.0
258	NF	07	ACNE	6	350.0	385.0	305	NF	10	ACNE	6	725.0	770.0
259	NF	07	ACNE	3	1180.0	1230.0	306	NF	10	ACNE	6	840.0	905.0
260	NF	07	BAEM	6	692.0	750.0	307	NF	10	BAEM	6	1360.0	1470.0
261	NF	07	BAEM	5	1107.0	1112.0	308	NF	10	BAEM	6	1710.0	1760.0
262	NF	07	BAGL	4	884.0	886.0	309	NF	10	CERE	3	0.0	40.0
263	NF	07	CERE	2	43.0	64.0	310	NF	10	FRVE	6	774.0	805.0
264	NF	07	FRVE	6	130.0	169.0	311	NF	10	FRVE	6	903.0	1037.0
265	NF	07	FRVE	6	248.0	270.0	312	NF	10	FRVE	6	1689.0	1834.0
266	NF	07	FRVE	3	1180.0	1230.0	313	NF	10	JUSC	6	775.0	781.0
267	NF	07	JUSC	6	504.0	530.0	314	NF	10	VIAR	6	774.0	810.0